COLD CANNED DRINK VENDING MACHINE AND ITS UPGRADE

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ABSTRACT

A cold canned drink vending machine is a kind of finite state machine with output models. A vending machine is a machine that dispenses merchandise when a customer deposits sufficient money into a slot or vend to purchase the desired item. Vending machine was first invented in 215 B.C. in Alexandria, Egypt. After centuries, nowadays there are many kinds of vending machines which dispense different merchandises. Today, vending machines are still being improved and upgraded. In Malaysia, most of the vending machines dispense snacks and drinks. Moreover, most of the vending machines are coin-operated. Therefore, one of the objectives of this research is to study and understand how a cold canned drink vending machine operates and its mechanism. Besides that, another objective is to upgrade the cold canned drink vending machine. The vending machine will be upgraded to have a display screen, become more polite and receive bank notes. Apply programming language to the vending machine is also an objective of this research. In this research, C++ programming is applied to the cold canned drink vending machine. There are six kinds of outputs for each Drink A, Drink B and Drink C due to the six different situations. However, in this research, only Drink A's outputs are shown as the situations are same for Drink B and Drink C. Although the program of the vending machine is created, it is not advanced. In conclusion, the objectives of this research are achieved, which are to study and understand the mechanism of the vending machine, to upgrade the cold canned drink vending machine and apply programming language to cold canned vending machine.

ABSTRAK

Mesin layan diri yang berjenis minuman ringan sejuk adalah sejenis Mesin Keadaan Terhingga yang mempunyai hasil keluaran. Mesin layan diri adalah sejenis mesin yang menjual barangan apabila seseorang memasukkan wang syling ke dalam slot untuk membeli barang. Mesin layan diri dicipta pada 215 S.M. di Alexandria, Egypt. Selepas beberapa abad, kini terdapat pelbagai jenis mesin layan diri yang menjual barangan yang berlainan. Mesin-mesin layan diri masih diperbaiki dan dipertingkatkan mutunya sehingga sekarang. Di Malaysia, kebanyakan mesin layan diri menjual makanan ringan dan minuman tin. Di samping itu, kebanyakan mesin layan diri berfungsi dengan menggunakan wang syling sahaja. Oleh itu, salah satu objektif kajian adalah untuk mempelajari dan memahami proses mesin layan diri berfungsi dan mekanismenya. Selain itu, objektif lain adalah untuk mempertingkatkan mutu dan penggunaan mesin layan diri yang berjenis minuman tin sejuk. Peningkatan mutu dan penggunaan tersebut termasuk mempunyai skrin yang lebih besar, menjadi lebih bersopan dan menerima wang kertas. Pengemukaan pengaturcaraan terhadap mesin layan diri juga merupakan salah satu objektif kajian ini. Dalam kajian ini, pengaturcaraan berorientasikan objek dikemukakan. Terdapat enam jenis hasil keluaran bagi minuman A, minuman B dan minuman C masing-masing, disebabkan oleh situasi-situasi yang berlainan. Walaubagaimanpun, hanya hasil keluaran minuman A yang akan ditunjukkan dalam kajian ini kerana situasi-situasinya bagi minuman B dan minuman C adalah sama. Sungguhpun pengaturcaraan mesin layan diri telah dihasilkan, namun pengaturcaraan ini masih mempunyai cacatan. Kesimpulannya, objektif-objektif kajian ini telah dicapai.

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LIST OF ABBREVIATIONS

ANSI	American National Standard Institution
BCPL	Basic Combined Programming Language
EPFL	Swiss Federal Institute of Technology Lausanne
FSM	Finite State Machine
GCJ	GNU Compiler for Java
HTML	Hypertext Markup Language
ISO	International Standard Organization
KTM	Keretapi Tanah Melayu
LRT	Light Rail Transit
OCL	Object Constraint Language
RAM	Random Access Memory
S.M.	Sebelum Masihi (Before Century)
UML	Unified Modeling Language
VHDL	VHSIC Hardware Description Language
VHSIC	Very High Speed Integrated Circuits
VSLI	Very Large Scale Integration

CHAPTER 1

INTRODUCTION

1.1 Introduction of Finite State Machine

Before introducing the vending machine, meaning of the finite state machine need to be studied.

A finite state machine is a device and technique that allows simple and accurate design of sequential logic and control functions. By using state machines, whether to design computer programs, sequential logic controls, or electronic control systems, sophisticated designs will be able to make (Gibson, 1998).

There are various types of finite state machine that being used in modeling. All finite state machines have a set of states, including a starting state, an input alphabet, and a transition function that assigns a next state to every pair of a state and an input (Johnsonbaugh, 2005). The states of a finite state machine have limited memory capabilities. Some finite state machines have no output but they do have final states. Such machines are extensively used in language recognition (Rosen, 2003).

Finite state machines are used extensively in variety of hardware computation structures such as sequential circuits in digital control systems, iterative networks, microprocessor control circuits, digital communication system, and others. Meanwhile, finite state machines are also used in software applications such as lexical analysis, parsing, pattern matching, neural networks, hypertext markup language (HTML) and the control portion of communication protocol specification (Lee, *et al.*, 1996). Besides engineering and programming, finite state machine's concepts are used for pattern recognition, artificial intelligence studies, language and behavioral psychology (Gibson, 1998).

There are two kinds of finite state machines, which are finite state machine with output and finite state machine without output. However, in this research, finite state machine with output is concentrated on.

1.2 Finite State Machine with Output

Finite state machine with output is the machine that produces an output symbol for each transition. This kind of machine can be used to model many kinds of machines such as vending machine, delays machine, binary adders and languages recognizer (Rosen, 2003).

1.2.1 Definition of Finite State Machine with Output

A finite state machine, $M = (S, I, O, f, g, s_0)$ consists of a finite set S of states, a finite input alphabet I, a finite output alphabet O, a transition function f that assigns to each

state and input pair a new state, an output function g that assigns to each state and input pair an output and an initial state s_0 (Rosen, 2003).

1.3 Vending Machine

In this paper, vending machine is focused on. Vending machine is one of the finite state machines with output models. A vending machine is a machine that dispenses merchandise when a customer deposits sufficient money into a slot or vend to purchase the desired item. The money, which is coins usually, is validated by a currency detector.

There are many types of items that can be vended from the vending machine such as snacks, beverages, newspaper, cigarettes, stamps, toys and others. Besides that, some modern vending machines dispense hot foods and drinks such as pizza, French Fries and coffee. Items that sold via the vending machine vary by country. For example, in United States, vending machines generally serve the purpose of selling snacks and beverages, but are also common in busy locations to sell newspaper. Besides that, another common class of vending machines is photo booths (http://en.wikipedia.org/wiki/Vending_Machine).

Japan has the highest number of vending machines per capita, with about one machine for every 23 people (http://en.wikipedia.org/wiki/Vending_Machine). In Japan, it seems to be no limit to what is sold by vending machines. The majority of machines in Japan are stocked with drinks, snacks, and cigarettes. However, there also

have vending machines that selling items such as bottle of liquor, cans of beer and potted plants.

In Malaysia, vending machines become more and more by years. There are also various types of items that can be dispensed from vending machines such as drink, snacks, stamps, cards, photo and others. Besides that, ticket machines are also can be found. The figures shown below are gumball machine (Figure 1.1), snack machine (Figure 1.2), soda machine (Figure 1.3) and toy machine (Figure 1.4).

Figure 1.1 Gumball Machine

(Source from http://www.1st-vending-machine-business.com/images/gumball1.jpg)

Figure 1.2 Snack Machine

(Source from http://www.vending101.com/images/smi345-5.jpg)

Figure 1.3 Soda Machine

(Source from http://www.idealcoffee.com/images/vending_coke_bottle_big.jpg)

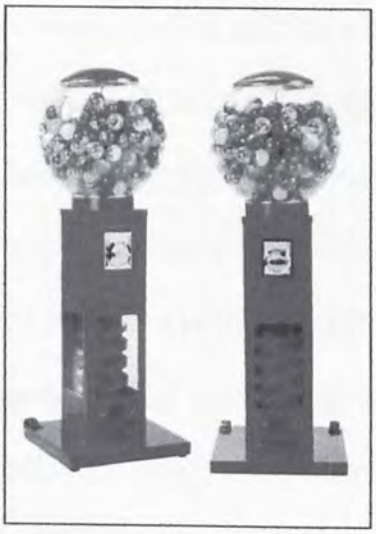

Figure 1.4 Toy Machine

(Source from http://img.alibaba.com/img/product/11/54/62/11546241.jpg)

1.4 History of Vending Machine

The first documented vending machine dates from about 215 B.C. in Alexandria, Egypt, where the ancient Greek mathematician Hero invented a device to dispense holy water to worshippers for ritual cleansing when they deposited a bronze coin. When a coin was deposited, it fell upon a pan attach to a lever. The lever opened up a valve which let some water flow out. The pan continued to tilt with the weight of the coin until it fell off, at which point a counter-weight would snap the lever back up and turn off the valve (http://en.wikipedia.org/wiki/Vending_Machine). Hero's coin-operated holy water vending machines inspired the creation of many other vending machines lending to a financial gain. It also jump-started the vending industry, allowing vending machine operators to make a supplemental income without having to be fully present.

Despite this early precedent, vending machines had to wait for the Industrial Age before they came to prominence. In 1880's, vending machines and vending machine technology were being challenged in Europe. Although many vending machines had been created, none of them were of commercial grade. In 1880s, the first commercial coin-operated vending machines, which dispensed post cards, were introduced in London, England. Besides that, inspired by the invention post card vending machine, Richard Carlisle, an English publisher and bookshop owner decided he wanted to profit from his own vending machine. Offering books from his shop, Carlisle's vending machine held six books at a time. The concept of the book vending machine transformed into invention of newspaper vending machines and magazine vending machines (http://www.vencoa.com/soft_drink_vending_machine.html).

The idea was then exported to the United States. One of the most popular items in the United States at the time was chewing gum. In 1888, the Thomas Adams Gum Company introduced the first gumball vending machine. The machines were installed on the elevated subway platforms in New York City and sold its popular Tutti-Fruitti gum. The idea of adding simple games to these machines as further incentive to entire people to buy came in 1897 when the Pulvar Manufacturing Company added small figures which would move around whenever somebody bought some gums from their machines (http://en.wikipedia.org/wiki/Vending_Machine).

In 1902, Horn & Hardart created the first vending machine restaurant. Joseph Horn and Paul Hardart called their vending machine an automat. Horn & Hardart's vending machines carried cafeteria-prepared foods that sat behind small glass windows. These vending machine restaurants were incredibly popular during the Depression, offering plenty of seating for customers to enjoy their food selections. The concept of a restaurant fully operated by ending machines has been carried over today with the increasing popularity of vending machines in break rooms and cafeterias. Fresh food vending machines, frozen food vending machines and specialty vending machines all provide full meal alternatives that are fast and relatively inexpensive (http://www.vencoa.com/soft_drink_vending_machine.html). The round candy coated gumball and gumball vending machines were introduced in 1907. This invention paved the way for round-top vending machines that dispense toys and candy.

Mirroring the concept of Hero of Alexandria's holy water vending machine, soda vending machines of the 1920's dispensed a trickle of soda into cups. By inserting a coin into the vending machine, soda would be dispensed into cups,

allowing a consistent amount of soda to be dispensed each time. The concept of this machine has evolved into hot beverage vending machines and fountain drink machines.

In 1962, William Rowe invented a cigarette vending machine. With the growing population of smokers, the match box vending machine was also created. There was a surge of vending machines being invented in the 1930's. During the Depression, a single cigarette vendor was invented, dispensing a single cigarette for a penny. A lotion dispensing vending machine was also invented during this time. Right after the Depression, a vending machine was invented that dispenses a box of cigarettes with a match box. This eliminated the need for two vending machines and led the way to the collaboration of vendable products, such as combination snack and soda vending machines (http://www.vencoa.com/soft_drink_vending_machine.html).

During 1930s, the bottled soft drink machines cooled with ice appeared on the market. In 1937, The Vendolator Co. in Fresno, CA had built the coca-cola bottle vendor. The canned soft drink vending machine was invented in 1965 (http://www.sdtimes.com/article/embedded-20021001-02.html). The vending machines were soon being improved. In 1972, the glass front snack machine was introduced by Polyvend (http://www.vending.org/about_nama/index.php?paye=main). Besides that, different kinds of vending machines were also being invented. In 1978, water vending machines were introduced and the French Fries machines were invented in 1983. Today, vending machines are still being improved and upgraded by people.

1.5 Objectives of Research

There are three main objectives for doing this research. The first objective is to study and understand how a cold canned drink vending machine operates and its mechanism. In Malaysia, most of the vending machines are coin-operated vending machine. Therefore, the second objective of the research is to upgrade the cold canned machine. The upgrades include a display screen and the vending machine will become more polite and receives bank notes. Besides that, the last objective of the research is to apply programming language in cold canned drink vending machine.

1.6 Scope of Research

The scope of this research is within the vending machine, which is a kind of finite state machine with output model, in Malaysia. This vending machine is about the cold canned drinking vending machine. Also, the programming language that will be applied in cold canned drink vending machine is C++ programming.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

There are a few of programming that can be applied to the vending machine, such as Java, Object Oriented Programming, Unified Modeling Language (UML), C++ Programming, Visual Basic and others. However, in our research, we only apply C++ Programming to the cold canned drink vending machine.

2.2 Apply Fondue to Drink Vending Machine

In 2004, Strohmeier *et al*. had presented a paper regarding applied Fondue to a drink machine. The purpose of their paper is to present the approach for specifying system behavior during analysis, part of the Fondue software development method. The approach is exemplified on a case study, a drink vending machine. It is based on Operation Schemas and a Protocol Model. The Protocol Model describes the temporal ordering of the system operations by an UML protocol state machine. An Operation Schema describes the functionality of a system operation by pre- and

postconditions (Strohmeier *et al.*, 2004).

2.2.1 Fondue

Fondue is an object-oriented software development method developed by the Software Engineering Lab of EPFL (Swiss Federal Institute of Technology Lausanne). Fondue covers in a consistent approach all phases from requirements elicitation and analysis, over design to implementation. According to Strohmeier, A., the Fondue method was first described in the paper named "UML Based Fusion Analysis Applied to a Bank Case Study", which is a proceeding that wrote by Sendall, S. and Strohmeier, A. (Sendall & Strohmeier, 1999), and then enhanced by the addition of a requirements elicitation activity (Sendall & Strohmeier, 2000).

Fondue has its origins in the well-known Fusion method (Coleman *et al.*, 1994). It adopts its process but uses the UML notations. In addition to Fusion, Use Cases are proposed for requirements elicitation and are taken into account during the analysis phase. The Fondue method not only provides an internal modeling of system-wide functionality and a step-by-step process that leads the development team from an object-oriented software system. Fondue defines a number of deliverables, one of which defines a specification of system behavior. The specification includes three principal views (Sendall & Strohmeier, 1999), which shown in Figure 2.1.

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