UNIVERSITI TEKNIKAL MALAYSIA MELAKA

REVERSE VENDING MACHINE

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Power Industry) with Honours.

by

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Tajuk: 45TReverse Vending Machine

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Power Industry) with Honours. The member of the supervisory is as follow:

Signature: ………………………………………….

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ABSTRACT

The Smart Recycle and Reward as the prototype of a Reverse Vending Machine (RVM). RVM is an innovative concept that has been introduced in western countries to help collect recycling materials and thus boot recycling activities. This project concept focused more on recycling system. Our project prototype allows the user to recycle beverage container for cans and receives reward points in term of money. This project uses one IR sensor module to detect motion, developed with Arduino set. Several sets of special coding have been applied to make the overall process runs smooth. The sensor module consists of servo motor. When a can or tin is being inserted, the servo motor will work to accept and record type of the material. At the same time, the servo motor prevents the can or tin from going down to the storage area during the record process. We can say that these processes are well-automated and runs in its own manner. This concept is quite similar to the normal vending machine, but for this project, it will be done by using the reverse concept which is, the users insert the cans and bottles inside the machine and get their reward like money. In this project, user can decide whether to put a single unit of the aluminium can and bottle plastic or put 4 unit of it all together. The machine is expected to function correctly and able to achieve the stated objectives. The important characteristic of studies for this project are user friendly, eco-friendly and have sustainability to be used widely in industry.

ABSTRACT

Alat Kitar Semula Pintar adalah prototaip kepada Mesin Layan Diri Songsang (Reverse Vending Machine) (RVM). RVM adalah satu inovasi yang telah diperkenalkan di negara barat untuk membantu mengumpul bahan-bahan kitar semula dan dengan itu mempromosikan aktiviti kitar semula. Projek ini memberi tumpuan kepada sistem kitar semula. Prototaip projek ini berfungsi dengan cara mengitar semula bahan-bahan terbuang dan memperoleh ganjaran berbentuk duit. Projek ini dirangka menggunakan satu modul IR sensor untuk mengesan pergerakan yang disambung kepada set Arduino. Beberapa rangkap pengekodan telah digunakan untuk memastikan keseluruhan projek berjalan lancar. Modul IR sensor mengandungi motor servo. Apabila tin, besi atau botol memasuki prototaip, servo motor akan mengesan pergerakan dan mengenalpasti jenis bahan yang dimasukkan, dan pada masa yang sama, motor servo akan berfungsi untuk menghalang bahan tersebut bergerak terlalu cepat ke tempat penyimpanan semasa proses mengenal pasti bahan sedang berjalan. Konsep ini sebenarnya adalah sama seperti mesin layan diri, tetapi untuk projek ini ia bekerja pada konsep terbalik yang bermaksud pengguna berpeluang memperoleh ganjaran berbentuk wand apabila memasukkan tin atau botol ke dalam mesin tersebut. Dalam projek ini, pengguna boleh membuat keputusan sama ada untuk meletakkan unit tunggal aluminium boleh dan botol plastik atau meletakkan 4 unit itu bersama-sama. Mesin ini dijangka berfungsi dengan baik dan mampu mencapai kesemua objektif. Kelebihan projek ini ialah ianya mesra alam, mesra pengguna dan mempunyai kelestarian untuk digunakan secara meluas di pasaran.

DEDICATION

To my beloved parents, family, lecturers, and friends, I acknowledge my sincere indebtedness and gratitude to them for their love, support and sacrifice throughout my life. The sacrifice has inspired me from the day I learn to read and write to the point of what I have progressed to be at this point. I cannot find the suitable words that could properly describe my appreciation for their dedication, support, faith in my ability to accomplish my dream.

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Alhamdulillah.

At last I am able to complete this project, that is about Reverse Vending Machine and submit it on time. First of all, I would like to start off by thanking Allah SWT, the most gracious and the most merciful for blessing us to finish this project. Without His guidance I would never be able to accomplish anything in my whole life.

I would also like to thank my parents for supporting my education for many years, and for encouraging, advising and guiding me in this life. I take this opportunity to express the deepest appreciation to my supervisor, Madam Siti Nur Suhaila Binti Mirin, for his patience guidance, enthusiastic and encouragement of this project. His willingness to give his time so generously has been very much appreciated.

Then, greatest gratitude goes to my friends, that have been advising me, helping me in many ways to make sure I will never give up in our life. Without the co-operation from them, it is difficult for me to complete this project on time. Thank you

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LIST OF SYMBOLS

D, d   -   Diameter

F   -   Force

g   -   Gravity = 9.81 m/s

I   -   Moment of inertia

1   -   Length

m   -   Mass

N   -   Rotational velocity

P   -   Pressure

Q   -   Volumetric flow-rate

r   -   Radius

T   -   Torque

Re   -   Reynold number

V   -   Velocity

w   -   Angular velocity

x   -   Displacement

z   -   Height

q   -   Angle

LIST OF ABBREVIATIONS

RVM	Reverse Vending Machine
PCA	Principal Component Analysis
VM	Vending Machine
LCA	Life Cycle Assessment
PET	Polyethylene terephthalate
PCD	Pollution Control Department
RTL	Register Transfer Level
MRF	Material Recovery Facilities
SBRM	Smart Bottle Recycle Machine
APR	Association of Postconsumer Plastic Recyclers
NAPCOR	National Association for PET Container Resources
RFID	Radio Frequency Identification
RFGA	Field Programmable Gate Array

CHAPTER 1

INTRODUCTION

This chapter discussion about general overview and briefly explain the project by stating the objectives, problem statement and the scope of projects

1.1 Background of study

Having a convenient system is vital in everyday life in this new modern era. People nowadays are more interested in something that works smart, effective and secure. The Reverse Vending Machine (RVM) is becoming one of the most effective way to promote recycle habit as it offers interesting rewards to encourage the people. [20] Example of recyclable material such as paper, bottles, cans, and bulbs. [20] [8] The reverse vending machine function is using vending machine concept, but its work on the reverse operating processes. [9] [10] The purpose of this project is to encourage recycling habit among the users and help them with the incentives in term of money.[12]

RVM's operation is very straightforward and simple. Users need to put their empty cans into the machine then the machine collects those cans and follow the instructions until the cash can be collected. [13] Nowadays, reverse vending machines are widely used in certain countries such as China, USA, Germany, Wales, Scotland, Ireland, Australia, Norway, Brazil, the Middle East and the UK.[11][20] In conjunction with this, Malaysia is also suitable for implementing this project for some reasons. This project is being installed in hospitals, schools, universities, department stores, shopping malls and offices. Developing Reverse Vending Machine can be one of the best ways to attract people to recycle activity. Since the sequence and concept has been changed, the functions of this machine have not been completely the same as normal vending machine. As usual, the normal selling machine will function as a machine that sells some product to people. While reverse vending machine will function as a machine that can buy some product from people like plastic bottle and aluminium.

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From here, people will gain money from waste that this reverse vending machine has accepted to recycle. Change from waste to money! In addition, each reward is based on how many quantities were recycled into the machine The more you recycle, more money you will gain.

Figure 1.1 : Recyclable materials such as glass, plastics, cans and paper

1.2 Problem Statement

There are some problem statements that need to be considered in developing reverse vending machine. First, there is less awareness about recycling materials such as paper, bottle, cans and glass. [21] [13] As know, there is less attention to recycling machine, especially reverse vending machine, in Malaysia. Although there are some machines that are used outside the country to recycle the materials used, they are not yet implemented in Malaysia. [14][20] It must be considering the cost of the machine that must be imported from outside inventors. The development of cans recycling machines is therefore on the right track and should be carried out in Malaysia as soon as possible to increase awareness of the importance of recycling materials, particularly cans.

To help to conserve the nature, one way we can do is recycle and perform reverse recycle for selected items.[21] [22]. Hence, Reverse Vending Machine (RVM) has been proposed to benefit both human and nature. [22] The main objective is to educate the users to practice recycling unwanted items.

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Figure 1.2 : A reverse vending machine used in Singapore. [22]

1.3 The Objectives

- To study the reverse vending machine principle.
- To design and develop reverse vending machine with Arduino prototype.
- To implement a user-friendly interface and display system for recycle reverse vending machine.
- To encourage people to practice recycle habit in their daily life.

1.4 Significance Of This Study

For this project, which is recycling aluminium cans and plastics, there is a lot of significance not only saving the energy and also avoiding the mining of new bauxite ore used for aluminium production. Aluminium cans can be recycled repeatedly, without losing their qualities.

This project will also make people get benefits from recycling. From that, the environment will stay in good conditions.

1.5 Scope Of Study

The scope of this project is focusing on the recycling method and the analysis made based on the process and flow of the machine functions.

The project involving the usage of thin woods as the housing, 1 module of Servo motor, LCD indicator, Coin Hopper and Arduino model. The first thing to do is, one housing made up from wood or plywood are built. Then, one hole is created to be the identification hole. Here the items are put. Here also at the bottom of the hole, is attached the Servo motor model, integrated with Arduino module.

Once the items are put into the hole and the type of items has been identified and recorded, the actual value of rewards earned will appeared on the LCD screen. At the same time, Coin Hopper will calculate the money and that amount of money will be rewarded to the users.

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1.6 Organization Of Thesis

In chapter 1, a brief overview has been done. It covers the problem statement that
becomes the motivation to complete the project, and set some targets or objectives to be achieved at the end of the project. Scope of work also has been stated to know the software used and process of the study.

In chapter 2, 22 references from journals and websites has become my sources to get the information. Information from websites are more focused to the general knowledge related to recycle and reverse recycle process. Whereas the information from journal are more focusing to the design of the machine's housing and the integration between Arduino module and Servo motor model.

For chapter 3, a flow chart shows the process of the project, divided to 9 phases, which is starting from literature review until report writing. The project uses hardware device such as LCD indicator and also plywood as housing for the vending machine and software devices such as Arduino module and Servo motor. Design and testing of the vending machine also be explained here especially in integrating the Arduino module with the Servo motor module. After that the real testing using real experiment tools take place and results has been recorded and being compared.

In chapter 4, explain about the design of the prototype. The design of the housing
has been changed and undergo tuning process to get the ideal performance of the Servo motor. Also, the material for the housing has been tested. Based on the results, changing the size of the housing and making adjustment on the housing's material affect the Servo motor performance.

For chapter 5, it is about the end product of the project, making conclusions about
it. Hence, for the future work, the Reverse Vending Machine design can be improved in some ways to get better results and better performance.

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CHAPTER 2

LITERATURE REVIEW

In this chapter, the previous study and analysis regarding recycle reverse vending machine will be conducted and compile as a literature review for this project. This chapter review on some of the sources such as paper, previous journals and websites as references in this project. All references have been cited.

2.1 THEORY

Life nowadays are getting faster and involving automation from times to times. Hence new technologies are deployed, and more sophisticated devices are created. Our life are getting easier, unfortunately, natural and raw materials have been used in order to create new technologies. Bauxite and tin ore are mined to create new robot and tree are chopped down to make paper. [21] We as the Earth people should play our role to save our raw material from used up.

Hence, one technology has been introduced to save our nature, that is called Reverse Vending Machine (RVM). [12] RVM is using the reverse operating system of the normal vending machine by providing rewards in terms of money to the users. The recyclable tems such as can and bottle can be reverse-recycle and hence, achieve the main objective, that is to educate the people to recycle items. [22]

My study will be focused on how to maximise the amount of items collected per one machine without neglecting its process efficiencies.[17] Since the size of the prototype is quite small, it can be installed anywhere, such as in mall, school or even in government office.

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2.2 CRITICAL LITERATURE REVIEW

REF	TITLE	REMARKS
[7]	Automatic Paper Vending Machine	- The machine was built with a microcontroller - Involved coin sensor - Focused on the recycling on paper only
[8]	Plastic Recycling Vending Machine	- Focused on recycling of plastics. - Have no proper detection system to detect the input is either plastic bottle or other kind of wastes that damages the whole system. - Use microcontroller as sensor - Prototype's weigh is 110kg and it can handle up to 400kg load.
[9]	Development of an automated reverse vending aluminum cans crusher	- This device ensures that only empty aluminum cans will be accepted by the machine. - Once a can is accepted, the upper geared motor drives the upper rotating table clockwise. If a can is rejected, the lower geared motor drives the lower rotating table clockwise. - Main body of the prototype, consist of Can Crusher, Can Acceptor and Rejector Device. - Use Coin Dispenser and Limit Switch to control the coin flowing out from the machine.
[10]	Reversible Vending: Features and World Practice	- Stated that technology of reverse vending can be implemented for an overwhelmingly large range of product packaging types (glass, paper, plastic, etc.) - Proof that further competitive tool because they can be more efficient than manual sorting and

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		moreover machines attract new consumers
[11]	Collection depots – reverse vending machine (RVM)	- The definition of 'collection depot' in the Environment Protection Act, 1993 (the Act) includes a reverse vending machine (RVM). - RVM must be installed at approved site once the application is approved by the Approval Holder.
[12]	Reverse Vending Machine and Its Impacts on Quantity and Quality of Recycled PET Bottles in Thailand	- Used P'PET, one of the most advanced RVMs in Thailand invented by Thai innovator. - accepts Polyethylene terephthalate (PET) bottles from the users and returns cash back to them. - P'PET is equipped with a barcode scanner and a high-sensitivity weight sensor to measure bottle weight. - The weight sensor, which will reject PET bottles if their weights do not match the profile. - P'PET is also equipped with 2G/3G cellular and WiFi network adaptors allowing the RVM to periodically update its bottles database
[13]	Smart Newspaper Vending Machine	- The microcontroller is used for the entire processing and is coded using the software "energia" tool. - The mechanical components include the rods, slider and high torque motors - The required voltage need to be stepped down to provide power to MSP430 system. - the slider is driven by using the 1000RPM DC motor. - Radio Frequency Identification (RFID) is used to provide communication between the user and controller.
[14]	Eco-Efficient Solutions for	- Only recycled PET and aluminum cans - Applied open or closed loop processes.

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