IMPLEMENTATION OF IOT AND IMAGE PROCESSING FOR REVERSE VENDING MACHINE

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DECLARATION

I declare that this thesis entitled "IMPLEMENTATION OF IOT AND IMAGE PROCESSING FOR REVERSE VENDING MACHINE is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this report entitled “IMPLEMENTATION OF IOT AND IMAGE PROCESSING FOR REVERSE VENDING MACHINE” and in my opinion, this thesis it complies the partial fulfillment for awarding the award of the degree of Bachelor of Electrical Engineering.

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DEDICATIONS

For my favorite parents.

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ABSTRACT

It is necessary to protect the world we live in in this society today, with the rising rate of ozone depletion. Recycling is one of the numerous ways of environmental protection to maintain a healthy hub for future generations. Recycling refers to the reprocessing for reuse of recycled waste material, which includes the collection, sorting, refining and conversion into a raw material which can be used to develop new items.

To make the recycling program more effective, many countries start to develop Reverse Vending Machine(RVM). This machine is the advanced technology to replace the recycle bin. Reverse vending machines have appeared all around the world. Especially in Japan, Norway, and Sweden. Our machine allows aluminium cans, plastic bottles, and carton boxes to be recycled by the customer thus earn incentives after recycling. This project is more focused on using image processing can classify the object into aluminium cans, plastic bottles, and drink carton box.

The manipulation of images via computers consists of digital image processing. In previous centuries, its use has been increasing significantly. Its uses range from healthcare, geographical processing, and remote sensing to entertainment. First, the data must be prepared to complete this project, which means starting with a collection of pictures and sorting them into their associated categories. So, develop a model of deep learning. It may be best to start with a pre-trained model while constructing a deep learning model from scratch. Train the model, then. Model training requires presenting to the model the performance data. The model will then iterate several times over the data and learn the most appropriate features related to the image automatically. Try to test the data after the train, after the model. Test the latest data that the model has not yet seen before to see that the picture is accepted by the model. All of the steps above can be done by using MATLAB software.

The IoT is a network which connected between the computer devices, mechanical and digital machinery, etc which able to transfer data without having any interaction. A person with a heart monitor implant, a farm animal with a biochip transponder, an automobile with built-in sensors to inform the driver when tire pressure is low, or any other natural or man-made object that can be issued an Internet Protocol (IP) address and can send data across a network are all examples of items in the IoT. Organizations across a wide range of industries are increasingly adopting this approach.

The manufacturing industry will gain substantially from the IoT, and the usage of sensors will considerably increase the quality and speed of the manufacturing process. Consider the idea of smart manufacturing systems that can make data-driven decisions and take corrective action to prevent causing damage to the components or systems. There are a variety of instances in which it is necessary to monitor a process and deliver an alert whenever a problem arises. Sensors and monitoring systems will aid in the resolution of these issues.

During a manufacturing process, we must keep an eye on the alignment of a component but with IoT system we are constructing must be able to detect this component's acceleration or deceleration. These factors play a significant role in the overall process quality. A component that transfers from one machine to another during the manufacturing process is an example of a scenario where this monitoring system might be used. In this case, we are interested in keeping track of its position, or, better yet, its alignment, as well as the forces operating on it.

What if we want to transmit an alarm as soon as something goes wrong with the production machinery, or if the component the machine is working on accelerates or decelerates throughout the manufacturing process? To accomplish this, the IoT monitoring system must be coupled with an IoT cloud platform so that we can send a short message to a user's mobile phone, for example.

IoT used in this reverse vending machine is to monitor the reverse vending machine condition. The apps or website that used to perform IoT is ThingSpeak. Through this website, we are allowed to monitor the reverse vending machine condition although we are far from the machine. Thus, when the reverse vending machine is full, the LED light in the website will change to red from green color and it will also send an email to notify us.

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LIST OF SYMBOLS AND ABBREVIATIONS

RVM	Reverse Vending Machine
IoT	Internet of Thing
DIP	Digital Image Processing
CNN	Convolutional Neural Networks
ANN	Artificial Neural Networks
PC	Personal Computer
ROM	Read-Only Memory
2D	2 Dimensional
3D	3 Dimensional
DN	Digital numbers
GND	Ground
WSN	Wireless Sensor Networks

CHAPTER 1

INTRODUCTION

1.1. Research Background

Why do we need reusing in our day-by-day life? Reusing is the main thing on our planet. It decreases the contamination that happens on our planet and defeats the dangerous atmospheric deviation issue. The advancement of Malaysia in territories of the climate is expanding and there is a need to zero in on them. Refuse squanders compromise the land and water assets at the same time and this is a major issue that should be raised with the partners (Fletcher and Brown, 2005). As per research, each day will have around 20,000 tons of junk being tossed on account of the addition in the populace in the nation. In 1993, Malaysia has begun the reusing effort. Reusing is one of the significant methodologies taken to overseeing waste adequately. In Malaysia, our administrations are needed to isolate the loss at home on 1 September 2015, yet this solitary included a few states which are Wilayah Persekutuan Kuala Lumpur, Melaka, Johor, Perlis, Kedah, and Negeri Sembilan. Presently, Malaysia is moving towards efficient strategies in overseeing waste and with the development of data innovation, the utilization of innovation in overseeing waste has stood out enough to be noticed these days. Besides, experience nationwide has shown us that remuneration is the smartest method to save the reuse cycle with a high level of support. The Reverse Vending Machine (RVM) idea is created to accomplish the target.

Reverse Vending Machine is also shortened as RVM. A reverse vending machine is a machine which allows people to return recycle things or empty beverage containers like plastic bottles, aluminium cans, drink carton box, etc. and get back a deposit or refund amount. The machine consists of several microcontrollers and sensors.

On 13 September 1920, Elmer M Jones and Sue Walker Vance introduced in America the first reverse vending machine called "Empty Container Return and Handling Machine". Wincanders from Sweden were invented in the 1950s and the first working bottle return system was developed. An advanced Automated Bottle Return Machine was designed by Aage Tveitan in 1962 and made by his organization Arthur Tveitan ASA in Norway. Thus, Kansmacker invented the first 3 in 1 machine in 1994 and is still in use today in Detroit, Michigan, while TOMRA Company developed the first fully automatic reverse vending machine in 1972.

The worldwide market to create a reverse vending machine is concentrated. The greater part of the market is split between a Norwegian organization TOMRA Ltd, a German organization Diebold Nixdorf and an American organization Envipco. TOMRA is the country's leading reverse vending machine manufacturer. The real-time image processing system is developed by TOMRA to distinguish the distinctive beverage holders by their weight and content.

In this project, the reverse vending machine is to uses image processing to detect an object. Image processing is a technique for conducting certain image operations, obtaining an improved image, or extracting useful data from it. In the 1960s, image processing or picture processing was invented. The input is an image of poor quality and the output is an image of enhanced efficiency. Common image processing includes image enhancement, restoration, encoding, and compression. In recent decades, image processing has been increasing significantly. Its uses range from medication, geographical processing, and remote sensing to entertainment. Since image trends, criteria, and applications are growing, it is more difficult to process images for desired objectives. In the computing world, this contributes to the concept of collecting, saving, locating, extracting, analyzing, and using images in everyday life. Digital imaging, as a computer-based technology, conducts automated analysis, manipulation, and visual data analysis. In various aspects of real life, it plays a major and significant role.

Image processing includes the following 3 steps. The initial step is Introducing the image via a digital camera or professional photography. Accordingly, examining and controlling the picture which incorporates information pressure and picture improvement and spotting designs that are not to human eyes like satellite photos. The yield is the last stage in which a modified image or report that depends on image research may be the result.

In image processing, there are two methods available, which are analog image processing and digital image processing. Analog image processing is applied to analog signals and only two-dimensional (2D) signals are processed. An electrical signal manipulates the images. Analog signals may be periodic or non-periodic in this image processing. An example of analog image processing is television imagery. One of the fastest-growing sectors impacting our lives is digital image processing. Besides, digital image processing is applied to digital images that are a mixture of tiny pixels and components. Some many tools and algorithms are implemented to perform adjustments to modify the images. An example of digital image processing is video processing. Digital image processing is also a unique type of processor used in all digital equipment, such as cell phones, satellites, pharmaceutical products, voice activation devices, etc.

In digital image processing, there are many procedures used to transform the digital image into an output image, such as image enhancement, image reconstruction, image analysis, and image compression. Picture enhancement is meant to generate a more attractive image and a better image for the viewer. Contrast improvement, edge improvement, spatial and frequency filtering, image combination, and noise reduction are included in this feature. The image quality, which has some distortions, should be strengthened through image restoration. This is widely used to enhance images sent to Earth from space camera systems in spacecraft imagery. For fuzzy pictures, image restoration can also be used. Image processing facilitates the performance of measurements and statistics, as well as image segmentation, extraction, and classification techniques. To reduce the quantity of the picture, image compression is used. This function is being used to reduced the transmission time of the image and to reduce the amount of space available for the image to be processed. Without improving integrity, compression can strengthen the image's efficiency. Table 1.1.1 shows the discrepancies between the processing of analog images and digital image processing.

Table 1.1.1: Discrepancies between the processing of analog images and digital image processing.

Analog Image Processing	Digital Image Processing
Slower and more costly system.	Cheaper and faster storage and retrieval of images.
It is time-varying signals, so the picture produced under the processing of analog images is varied.	It increases the digital quality of the picture and it is ideal for the distribution of intensity.
The analog signal is real-world picture quality, but not a good one.	It uses good techniques to compact images that decrease the amount of data needed and produce a good image.
It is continuous and not divided into small parts.	It uses a technique of image segmentation that is used to detect discontinuity due to a broken link path.

It is applied to analog signals and only treats two-dimensional signals.	Applied to digital signals that analyze and tamper with the images.

Although the Internet of Things (IoT) is twenty-two years old, the idea of connected gadgets has been around for much longer when the 1970s. The idea was dubbed "embedded internet" or "pervasive computing" at the time. Kevin Ashton created the term "Internet of Things" in 1999 while working at Procter & Gamble. Ashton, who worked in supply chain optimization, sought to bring the attention of upper management to an interesting new technology called RFID. He titled his presentation "Internet of Things" since the internet was the biggest new idea in 1999 and it made sense. Even though Kevin piqued the curiosity of several P&G executives, the term "Internet of Things" did not catch on for the following ten years.

Figure 1.1.1: Creator of IoT.

In the summer of 2010, the IoT concept began to gain traction. According to information disclosed, Google's Street View service not only took 360-degree photos but also saved a ton of data from people's Wi-Fi networks. People were wondering whether this was the start of a new Google plan to index the physical world in addition to the internet. The Chinese government announced the same year that the IoT will be a strategic focus in their Five-Year Plan. Gartner, the market research firm that coined the term "hype-cycle for emerging technologies," added a new phenomenon to its list in 2011: "The Internet of Things." The “Internet of Things” was the focus of Europe's largest Internet conference, LeWeb, the following year. However, famous tech publications such as Forbes, Fast Company, and Wired began using the term "Internet of Things" to characterize the phenomenon. According to a report issued by IDC in October 2013, the IoTs market would be worth $8.9 trillion by 2020. When Google announced in January 2014 that it would buy Nest for $3.2 billion, the term

"Internet of Things" became widely known. The Consumer Electronics Show (CES) in Las Vegas was also themed around IoT at the same time.

In its broadest definition, the term IoT refers to everything that is connected to the internet, but it is increasingly being used to refer to objects that can communicate with one another. The IoT is made up of devices ranging from simple sensors to smartphones and wearables that are all connected, according to Matthew Evans, the IoT programmer head at techUK. It is feasible to collect data, evaluate it, and act on it by connecting connected devices with automated processes. Caroline Gorski, the leader of the IoT at Digital Catapult, adds, "It's about networks, it's about devices, and it's about data." IoT allows devices connected to closed private internet networks to communicate with one another and connect them. It also enables devices to talk not just within narrow silos, but across various networking kinds, resulting in a far more connected society.

What is IoT monitoring? IoT monitoring is the process of monitoring, evaluating, discovering, and managing your connected devices. IoT monitoring is to keep you informed about any issues associated with your IoT assets affecting business-critical applications and service performance.

1.2. Problem Statement

Some reverse vending machines use a sensor such as proximity sensors to classify the object. The sensor is a very good tool but they also have some disadvantages which are limited lifespan, expensive, and need some time to detect and classify the object. If a reverse vending machine use sensor such as proximity sensor to detect the aluminum object, the machine will only classify the object into aluminum and non-aluminum object. Thus, to improve the sensitivity and the performance of the machine, use a software method which is image processing to detect and classify the object.

Figure 1.2.1:Proximity Sensor

The developing requirement for productively handling and investigating the data contained in the digital image is a test to apply picture preparation and computer vision technologies. Digital images are generally prepared in a savage power style, by examining all the pixels contained in the pictures, regardless of how large they are. Since pictures may contain plenty of pixels, any consecutive preparation upon them turns out to be effectively monotonous, in any event, for the quickest processors, restricting in this way the intricacy of the visual assignments that can be performed with progress.

With the development of technology, software in our world is widely used. During those few years, hardware was replaced by software. Image processing is a system by which an object can be identified and labeled. In other applications, such as robotics, x-rays, and so on, this approach is commonly used image processing can read and extract information from the object, so the computer can use or apply this method to the reverse vending machine to detect and recognize the item in a really short period.

If an RVM without connecting to an IoT, the creator or the producer cannot perform a real-time monitor of the machine for a long distance. A system without connecting with an IoT will bring many disadvantages. Without an IoT platform, the producer does not know if the RVM is full and cannot receive any recycled things anymore. This will make the number of recycled things lesser because when the RVM is full but they didn't notice and collect it.

Without IoT, the system will not run smoothly. With devices connect through the Internet to drive operations, managers, and analysts have more time on their hands to focus on their core business. IoT will give complete data of the supply chain, manufacturing, customer engagement, and so on thus can efficiently manage things. But without IoT, all of this cannot be done or without IoT, the RVM cannot run smoothly.

Lastly, without IoT for the RVM system will also increase the cost. This is because we did not know the RVM's condition, we don't know whether it is full or not. Thus, to make sure the RVM can perform well or can receive recycled things, we need to go to check the condition of the RVM. This will increase the man-power cost and petrol cost.

1.3. Objective

This project is to implement IoT and image processing for a reverse vending machine. In order to achieve that, the objectives of the project are:

I. To create a sorting system of the reverse vending machine based on image processing.

II. To design a sorting mechanism that can segregate 3 types of wastes.

III. Performance analysis for the waste detection part of the RVM based on the segregation timing.

IV. To implement a real-time cloud computing database function for RVM.

V. To implement an alerting system for when the RVM is full.

1.4. Scope of the project

The scope of this project is to use image processing to classify the object into drink carton boxes, aluminium cans, and plastic bottles and to perform real-time monitor by using IoT. To complete this project, need both hardware and software. MATLAB software to run the image processing program. First, must create a database for the machine. The database is the picture of a recyclable object but in different sizes, shapes, colors, etc. Due to some limitations, the camera that was used in this project is a laptop camera which also control by the Matlab software.

For the IoT and hardware part, used the ultrasonic sensor to detect the condition of the reverse vending machine and used NodeMCU board to send the data to the IoT platform. The NodeMCU board act as the bridge between the sensor and IoT platform. Thus, the ThingSpeak platform is also used to monitor the system. Once the reverse vending machine is full, the IoT system will send an email to notify me. LED also one of the hardware that used in this project. The function of the LED in the IoT platform and the hardware is to let us know the condition of the reverse vending machine. LED will change to red color from green color when the reverse vending machine is full.

1.5. Project Outline

This report consists of 5 chapters that cover the implementation of IoT and image processing for the reverse vending machine.

Chapter 1 consists of the introduction of a reverse vending machine, image processing, and IoT. This chapter also discussed the project background, motivation, objective, and scope of the project.

Then, chapter 2 consists of the literature review of the topic and facts. This chapter will be discussed about the reverse vending machine, IoT, image processing, etc.

Besides that, chapter 3 consists of the methodology of this project.

Thus, chapter 4 will analyze and discuss the result obtained from the image processing part and also IoT part.

Lastly, chapter 5 will discuss the conclusion obtained from this project. This chapter will also discuss the recommendation for this project.