Waste and garbage recycling vending machine

CHAPTER ONE

1.0 INTRODUCTION

Recycling is an important part of proper waste management. It entails the specific collection of discarded materials and their processing into new objects still, the level of awareness around recycling has proven to be low as people frequently abuse them. This Challenge shows that Nigerians has not yet come of age to add Value into an efficient solid waste management system. Industrial View Recycling, as a part of the Industrial sector. It is vital in waste management strategy since there is limited land into which to put our discarded materials (landfills), and incineration generates air pollution (Sapida, 2020)

As of late, countries like China, India, and Malaysia have started arranging order for waste administration. As information technology rapidly progressed, the tendency to implement technology in waste management becomes evident. But these Raspberry Pi-driven devices and others show that tech can help authorities in waste management. More importantly, these type of technology can promote people to recycle or segragate with waste effectively. Moreover, global experiences indicates that reward is the most effective approach to keep humans at the highest possible level of participation in recycling process (Rahim, N.H.A and khatib, A.N.H.M, 2021)

Now, in order to achieve the aforementioned recycling goals, a great way is the introduction of the Reverse Vending Machine (RVM) concept whereby users are given incentives for proper disposal. RVM itself is a unique solution which helps to gather the recyclable materials in an effective way and it encourages recyclables household engagement and better waste management, more generally, and to be specific for this article, RVMs are utilized to motivate communities in the right disposal of common recyclable materials like plastic, paper and aluminum. Due to a variety of research on RVM development, these related works can be generally divided into sections according to the power supply generation; types of microcontroller and sensing mechanisms.

Our system differs from the previous Reverse vending machines by integrating the developed system into a standard recycling bin while maintaining the conventional procedure for users to dispose of waste. This product evaluates the value of disposed waste based on its weight, type, and current market price of recyclable materials.

OVERALL ISSUES RELATING TO THE RECYCLING OF WASTE AND GARBAGE

To maintain a sustainable future, we must understand and address the main management of waste issues. The main issues are listed below

I. Meeting Compliance Demands: Regulations of recycling, garbage disposal, and environmental protection are complicated and constantly changing, and waste management companies must comply with them. Proper maintenance can be challenging and requires continuous monitoring and adjustment. These regulations are readily forgotten if they are not given thoughtful consideration, which could result in significant compliance expenses.

Solution: In a situation like this, putting in place a system for handling waste disposal can be helpful. The use of technology with the aid of Automation lowers the likelihood of oversight by ensuring that tasks are finished accurately and on schedule. Systems for monitoring waste aid in maintaining regular operations and assuring proper handling. They make data more accessible and shareable with the regulatory bodies.

II. Increase in Operational Expenses: The expenses of garbage collection, transportation, and treatment are among the rising operational costs that waste management organizations must tackle with. There are many factors under this issue, some of which are labor expenses, fuel prices, and maintenance expenditures cause these high costs.

Solution: By making provisions to insight into processes, logistics disposal solutions lower operating cost. Managers may improve routes by monitoring garbage trucks, lowering pollutants, using less fuel, and increasing total efficiency.

III. Recyclable Material Contamination: One recurring problem in waste management is the contamination of recyclable materials. Getting high recycling rates can be hard when there is no separation between non-recyclables and recyclables since this lowers the quality and marketability of the recycled materials.

Solution: Waste monitoring systems increase the state of quality of recyclable materials by implementing monitoring procedures at recycling facilities, which helps lower contamination.

IV. False Information and Reporting: Human errors can arise from forgetfulness, haste, or laziness when manual data gathering is used. The decisions made by waste management organizations is due to inaccurate data. If the data is accurate there will be a good record for waste management and vice versa

Solution: This issue can be resolved by spending money on asset-tracking solutions. Computers cannot make mistakes, its garbage in garbage out which occurs in real-time operational data on waste management. By analyzing this data, businesses may improve operational efficiency and streamline procedures. Making informed decisions is further aided by data analytics tools.

V. Ineffective Collection Systems: In a situation where there is an ineffective waste collection system due to improper handling of waste in communities, there is waste accumulation and insufficient garbage removal. Inefficiency is demonstrated by problems including poor scheduling, poorly placed bins, and insufficient collection services.

Solution: Route optimization and efficiency can be increased by utilizing cutting-edge technologies, such as trash tracking systems for collection trucks. Software for monitoring waste focus on the condition and consumption of resources like compactors, bins, and containers. Businesses can use this information to plan maintenance, minimize downtime, and optimize asset allocation for a more effective system.

GENERAL IMPORTANCE OF EMBEDDED SYSTEMS

The importance of embedded systems cannot be overemphasized. Some of their importance are listed below.

• Real-time control and processing: Embedded systems have real-time control and processing capabilities. Helps waste recyclers respond and adapt quickly to changing environments. Reading barcodes is essential for vending machine recycling. A well-designed barcode reading system can speed up the process and prevent unwanted materials from entering the system.

• Sensor integration: Embedded systems integrate various sensors. In the waste recycling machine more conveniently the sensor is ultrasonic, durable and resistant to water and shock. Fully functional over a wide temperature range and able to measure distances from 3 centimeters to 12 meters, the sensor can detect various types of trash and rubbish. In containers of various sizes, trash cans and garbage compactors.

• Energy Efficiency Scale Optimization: Embedded systems are designed to be energy efficient and compact. This makes it ideal for integration into waste recycling where inherent resources are limited...

• Customization and flexibility: Developers can modify the features of waste recycling equipment to meet specific tasks. We can't thank embedded systems enough for their flexibility and customization options. The design and development of prototyping techniques is made possible by using the open source nature of many embedded platforms, such as Raspberry Pi 3, which guarantees access to software tools, libraries, and community support (Dousai and Loncaric, 2021).

1.1 PROBLEM STATEMENT

Current self-recycling practices that require users to take large amounts of waste to a recycling center can be inconvenient and discourage people from recycling. The design and development of a waste and garbage recycling vending machine using raspberry pi 3, scanners, an ultrasonic sensor and some other components after which the sensor detects it to select garbage or waste to be recycled. Providing solutions to these problems

1.2 AIM

The aim of the project is to design a reverse vending machine that accepts recyclable waste and rewards users for donating and choosing whether that waste should be recycled or not.

1.3 OBJECTIVES

The objectives of this project are

i. Gather the requirements for a waste and garbage recycling system
ii. Design the model for the system acceding to the requirement in (I)
iii. Implement the system designed in (II)
iv. Evaluate the system implemented in (III)

METHODOLOGY

First and foremost, we create Component design and system specifications
Second, create a prototype using a conveyor belt. Barcode scanner, Servo motor and trash can
Three. Test prototype
Fourth, developing software for barcode recognition and lastly we Set up and test the system in a real environment.

1.4 SCOPE OF STUDY

The importance of this project lies in its ability to address key challenges facing the modern workplace. Develop an automatic waste management system specifically adapted for common areas. We strive to increase operational efficiency, reduce costs, reduce errors, and improve the overall productivity of our environment. This project provides a unique opportunity to use cutting-edge technology to solve real problems within the workplace. This is in line with the growing trend of office automation and robots.

CORPORATE REPORT

This report provides a comprehensive overview of the project. It details objectives, methods, actions, results, and future work. Embedded systems play a key role in this project.

There are several reasons why embedded systems play an important role in the development of reverse vending machines. Embedded integration with waste, garbage, recycling and vending machines increases production capacity. It helps automate tasks and perform complex tasks efficiently.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

Reverse vending machines (RVM) have emerged as a feasible strategy to the increasing demanding situations of waste management and recycling. This is mainly actual for plastic baggage and other recycled objects. This literature review explores the effectiveness of RVM in selling recycling efforts, checks the layout and operational features and spotlight key regions for similarly research and improvement. Increasing waste volumes and inefficiencies in modern series and recycling structures and create extensive environmental and financial problems. Traditional recycling techniques frequently face issues such as low collection charges, contamination, and constrained sorting skills. This results in less efficient recycling. In particular plastic waste, it is an essential trouble due to its environmental patience and potential dangers to ecosystems and human fitness. RVM offers an incentivized technique to selling recycling with the aid of worthwhile customers for putting off recycled substances. This will help increase recycling rates. Improve garbage collection efficiency and to reduce reliance on landfills, RVMs can also be equipped with sorting mechanisms to separate different types of recyclable materials. This helps make the recycling process more efficient and higher quality recycled materials.

From the above mentioned this chapter therefore begins the literature review. Several studies have examined the design and performance characteristics of RVMs. This current effort attempts to initiate a literature review to understand some of the previous work on waste recycling vending machines to identify their participation and the gap that this study attempts to fill. Important considerations include material identification and sorting, rewarding system Collection.

2.1 STUDY OF REVERSE VENDING MACHINES

A reverse merchandising device is a tool that allows customers to return empty beverage packing containers together with cans and bottles. To be recycled This isn't like conventional merchandising machines in which users insert cash to acquire merchandise. Reverse merchandising machines provide refunds or refunds of deposits in trade for returned packing containers (Tomra, 2017).

These machines are geared up with diverse sensors. For packaging processing, consisting of weight sensors (load cells) and infrared sensors for high-quality inspection. The device has a conveyor belt. Lid controller to handle incoming cans. 350 Watt DC motor to compress cans.

Lid controller to control the can directly sorting boxes and work in progress (Watanyulertsakul, 2019)

2.2 Design and implementation of a waste and garbage recycling vending machines past work

Tomari et al. (2019) in their research acknowledged that general RVM tends to accept a wide range of materials. This leads to contamination and inefficiencies in recycling. This mixed waste requires additional classification, reduces the quality of recycled materials and reduce economic value Contamination also raises concerns about safety and health risks during the manufacturing process. The authors propose an RVM equipped with material detection sensors to address this issue. The RVM prototype uses sensors to identify specific materials, such as PET bottles, cans and aluminum before recycling. The research focuses on testing the accuracy of material identification systems and their impact on recycling benefits. The model achieved an average accuracy of 82.5% in identifying the target material. The authors argue that content separation should be improved. The research topic is relevant and important, the lack of detailed methodology and concrete results weakens the article. The absence of practical implementation or field testing limits the article’s impact. Without real-world validation, it remains theoretical. Future work should focus on building and testing a prototype of the recycling machine, collecting data on its efficiency, and addressing any limitations.

Bull et al. (2018) introduced a straightforward design for a reverse vending machine (RVM) using fraud detection sensors. The system is activated when plastic material is inserted and tested through a series of sensors. Consists of a strain gauge weight sensor, Capacitive Proximity Sensor and infrared photoelectric sensors for fraud detection.

The RVM accepts plastic items and dispenses coins as rewards based on the weight of the plastic. This design is implemented using Xilinx and Verilog.

Sambhi and Dahiya (2020) focused on improving the management of plastic waste, in particular plastic bottles frequently used for beverages. Plastic pollutants is a prime environmental hassle. This is especially authentic whilst those gadgets turn out to be in landfills or in marine environments. Their research offers a solution through reverse vending machines which includes sensors Lab view programming, data collection and pneumatic technology. This cost-effective machine crushes plastic bags to reduce their size. This reduces the storage space required for disposal by using less energy in the recycling process, the machine supports environmental sustainability. Although the article does not provide specific performance data, the concept supports the "cash-from-trash" idea, where recycled plastic is converted into useful products, helping to lower greenhouse gas emissions and pollution. Although there are promising trends but the lack of detailed methods and empirical results limits the article's impact. Real use and field testing are very important to evaluate the performance of such reverse sales equipment.

Wong et al. (2019) sought to improve recycling practices. This often requires individuals to transport large amounts of waste to recycling centers. This is a system that may be uncomfortable and discouraging. With the aim of developing an automated device that promotes recycling via a reward mechanism, they created a Reverse Vending Machine (RVM) designed to accept plastic, steel, and different recyclable substances. The system rewards you instantly when the correct recycled material is detected. It also tracks user data. Measure the weight of waste and convert this weight into points that can be redeemed with RFID point cards. This will assist calculate the applicable cash prize.

Lokman (2023) centered his look at on challenges related to reverse merchandising machines (RVMs) used in recycling. Especially that specialize in RVM chassis layout and green garage gadget. The purpose changed into to beautify the functionality, aesthetics, and practicality of RVMs Maintenance and long-term user engagement In addition to combining socio-economic and cultural considerations, RVM adoption and effectiveness can be improved.

Amantayeva et al. (2021) address the challenges of waste management in Kazakhstan. It focuses on the collection and recycling of plastics. Although the government tries to separate and recycle waste, and the willingness of the public But there is still a lack of effective strategies to promote plastic recycling. This study explores the potential for integrating machines for trading in turn. The group created a system model and functional float block diagram (FFBD) for RVM, addressing the recognized needs and Risk analysis with proposed mitigation techniques. The observation emphasizes the possibility of integrating RVM into Kazakhstan's waste control system and assess the importance of consumer demand for expertise and dangers. It gives a strategic method to enhancing waste control and environmental sustainability in a rustic facing ongoing waste demanding situations. Further studies are recognition on scalability, Maintenance and long-term consumer engagement including the integration of socio-economic and cultural factors to increase RVM adoption.

Karin et al. (2016) added a Field Programmable Gate Array (FPGA) based device for a bottle recycling gadget. The system helps users recycle plastic bottles and earn reward points. The FPGA was chosen for better speed when running on the hardware. Compared to software-based solutions on microcontrollers. The design includes an ultrasonic sensor to detect bottles of various sizes. This will help calculate the relevant cash prize.

Lokman (2023) centered his study at the demanding situations related to reverse vending machines (RVMs) used in recycling. Special interest became paid to the layout of the RVM chassis and efficient garage gadget. The goal is to enhance the overall performance, aesthetics, and practicality of RVM. The researchers sought advice from RVM, a gift from modern patents, to generate ideas. The concept was decided upon and modeled using the SolidWorks software program. It looks like calculations and evaluations were done to assess the general overall performance of the tool. The format ends in an amazingly designed RVM that seamlessly integrates with waste management systems. Storage optimization allows for optimal management of RVM recycling. Unique modeling and visualization is possible using SolidWorks, although this article provides an outline But comparable research should explore real-world applications, sustainability, and consumer interactions. Considering the challenges of international operations in the real world and individual opinions. It will enhance the efficiency of RVM...

Sony et al. (2020) Address waste control challenges for the duration of the COVID-19 pandemic. In unique, the usage of plastic bottles and associated waste is growing

They developed a system designed to efficiently control used beverage bottles and calculate monetary rewards for consumers. This system aims to promote recycling. Especially in developing countries such as India, Pakistan, south sudan and Nigeria. Arduino microcontrollers, capacitive proximity sensors and motors are used. The capacitor sensor is placed on a conveyor belt while the microcontroller manages the servo motor for counting bottles and calculating the return amount. The system also sorts bottles by material type and prints the corresponding refund price. Such measures promote waste reduction and are in line with initiatives such as Smart Cities and Swachh Bharat Abhiyan. Although this article highlights the design and functionality of an Arduino-based Reverse Vending Machine, more research is needed to address the issue. This Scalability Maintenance and user acceptance can further increase system performance. At the same time, it addresses practical challenges and cultural considerations.

Rahim and Khatib (2021) aimed their look at to address the demanding situations associated with plastic waste control. In unique, the point of interest is on polyethylene terephthalate (PET) plastic bottles. Plastic bottles and packing containers were found in landfills and it create harm to the surroundings. Researchers sought to layout a reverse vending machine (RVM) that now not most effective encourages recycling but also promotes recycling and also destroys PET bottles for efficient recycling. The goal is to reduce waste and promote responsible disposal. The developed RVM incorporates a disruptive feature for handling PET bottles. The main components include a capacitive sensor for bottle detection, Liquid crystal display (LCD) for status indication and an Arduino UNO microcontroller. The system activates two direct current (DC) motors, one for breaking PET bottles and the other for delivering coins as rewards. Consumers receive rewards based on the number of bottles inserted. The RVM is designed for placement near streets, buildings, and convenience stores. The PET bottle shredder RVM effectively shreds standard-sized empty PET bottles. Users are incentivized to recycle, contributing to waste reduction and environmental sustainability. The project benefits consumers by eliminating the need to visit recycling centers for PET bottle disposal. While the article emphasizes the RVM's design, further research could explore scalability, maintenance, and user acceptance. Considering real-world deployment challenges and cultural factors would enhance the RVM's impact.

The researchers in Desai et al. (2017) sought to design an automatic chocolate vending machine that could efficiently dispense various types of chocolates. The primary objective was to introduce a new technology application to society by leveraging the capabilities of the Arduino Uno platform. The research team used the Arduino Uno microcontroller board as the foundation for their vending machine. The assembly of the machine involved gears, bevels, and racks to facilitate the dispensing process.

Vending machines are designed to perform on a foreign money-primarily based transaction basis. Their work is an Arduino-based merchandising machine which could sell different varieties of chocolate. By connecting an Arduino Uno, the researchers have achieved an green and automated device for chocolate transport. Although research has been a hit in demonstrating the feasibility of Arduino-based totally merchandising machines, there may additionally nevertheless be room for improvement. Further studies will check enhancing the person interface and fashionable enjoy for clients. It is vital to defend the protection of your enterprise machines from tampering or gaining unauthorized access. Regular renovation and inspections of machines are vital to keeping efficiency.

Tan and Azam (2021) stated that waste management is an important problem in modern society. Reverse vending machines (RVM) often use sensors to classify merchandise. They can be expensive and have a limited lifespan. To overcome these limitations, Researchers propose to integrate advanced image processing technology into RVM. They focus on improving the sorting mechanism using image processing techniques such as optimization, segmentation, and feature extraction classification using Convolutional Neural Networks (CNNs), specifically ResNet-50, with Support Vector Machine (SVM) classification, this system is aimed at aluminum, cans, beverage cartons and polyethylene terephthalate (PET) bottles are properly classified and arranged. This image processing method has increased the efficiency of RVM and reduced its reliance on conventional sensors. Although this study provides valuable advances in waste management, but it also emphasizes the need to increase public awareness of the benefits of regular RVM maintenance and cooperation with waste management agencies to expand the use of RVM.

In summary, RVM represents a promising technology to address waste management challenges and promote recycling, however, further research is needed to address its scalability. User behavior system integration and environmental impact assessment to ensure its optimal use and maximize its positive contribution to a more sustainable future.

CHAPTER THREE

METHODLOGY

Sorting waste of various sizes and shapes is achievable, but efficiency improves when dealing with cylindrical or cubic objects, provided they are within certain size constraints.

Keys areas where the project focuses on

1. Environmental Impact: Waste vending machines reduce landfill use by promoting recycling and facilitate resource recovery by the collection and reusing materials like wastes like plastics.

2. Economic Benefits: These machines provide incentives for recycling, encouraging public participation, and help lower waste management and processing costs.

3. Technological Advancements: The waste recycling machines use advanced technologies like Raspberry pi and IoT for efficient sorting and data collection, aiding in waste management planning and policy-making.

4. Policy Support: Waste and garbage recycling vending machine help meet waste management regulations and promote a circular economy by encouraging the reuse of materials.

3.0 REQUIREMENTS

This explains a thorough research conducted to understand current waste and garbage vending machine systems and identify the specific requirements and challenges for developing an improved solution.

3.1 STUDY ON EXISTING RECYCLING VENDING MACHINE

The existing processes for waste and garbage vending machines, also known as reverse vending machines (RVMs), involve several key steps:

1. Collection and identification: Users drop off recyclable items such as plastic bottles, aluminum cans or glass container into the machine. The machine will identify the type and contents of the deposited item through technology using sensors and cameras, such as a barcode scanner. Weight sensor and size detection.

2. Sorting and Processing: Once identified, the machine sorts the items into different bins based on material type. Some machines also compact the items to reduce their volume, making transport and storage efficient.

3. Incentive Distribution: Users receive incentives for depositing recyclables, which can include cash or points redeemable for goods or services. The machine completes the transaction by printing a receipt or adding the rewards to a user account.

4. Data Collection and Management: The machine logs data on the type and quantity of items collected, user interactions, and maintenance needs. Many RVMs are connected to the internet, allowing for remote monitoring and management by operators.

5. Maintenance and Service: Regular maintenance is done to ensure optimum performance. Including emptying the tank Cleaning the sensor Software updates and prompt repairs to correct technical problems or defects.

6. Recycling and Waste Management: The accumulated recyclables are sent to a recycling plant for in addition processing. In recycling flora, substances are separated, wiped clean, and processed into uncooked materials that may be used to make new merchandise.

3.2 DESCRIPTION OF ADDITIVES

Raspberry PI

The Raspberry Pi three launched in February 2016 because the 1/3 generation successor to the Raspberry Pi 2 Model B. It has a quad-center 1.2 GHz 64-bit ARMv8 CPU, 802.11n Wi-Fi LAN, and Bluetooth four.1. Raspberry Pi has several models. Similarities With model 2, there is 1GB of RAM, 4 USB ports, a 40-pin GPIO port, a Full HDMI port, an Ethernet port, and audio included. 3.5mm jack and composite video output, camera interface, display interface and a micro SD card slot with Video Core IV 3D graphics core.

As apparent in Figure 3.1, the Raspberry Pi 3's processor is agnate to the dent acclimated in aboriginal smartphones of the era, although its CPU is based on the earlier ARMv6 architecture. The Raspberry Pi 2 has a 900 MHz 32-bit quad-core. ARM Cortex -based A7 processor and Broadcom BCM2836 SoC and 256 with KB aggregate L2 cache. In comparison, Raspberry Pi three is in a position with Broadcom BCM2837 SoC which incorporates the processor. Quad-middle 1.2 GHz 64-bit ARM Cortex-A53 and 512 KB collected L2 cache

There are two capital models of Raspberry Pi: A and B. Named afterwards the aboriginal BBC microcomputer, Model A has 256 MB of RAM and a USB port, accouterment a added fee-effective and introduced strength-green advantage in comparison to Model B. Model B moreover has USB port, Ethernet anchorage for networking, and brought 512 MB RAM Both the A and B models accept been acclimatized to the A and B variations, which accommodate improvements inclusive of introduced USB ports and bigger ability performance.

Released in February 2016, it is the 1/3 bearing almsman to the Raspberry Pi 2 Model B. It appearance a quad-center 1.2 GHz 64-bit ARMv8 CPU, 802.11n wireless LAN, and Bluetooth four.1. This Raspberry Pi has abounding similarities. With the 2d bearing such as 1GB RAM, 4 USB ports, 40 GPIO pins, abounding HDMI port, Ethernet port, Integrated 3.5mm audio jack and combined video output, digital camera interface, affectation interface and a micro SD time table aperture with Video Amount IV 3-d cartoon center.

As obvious in Figure three.1, the Raspberry Pi three's processor is agnate to the dent acclimated in aboriginal smartphones of the generation, even though its CPU is primarily based at the ahead ARMv6 structure. The Raspberry Pi 2 has a 900 MHz 32-bit quad-center.

As apparent in Figure 3.1, the Raspberry Pi 3's processor is agnate to the dent acclimated in aboriginal smartphones of the era, although its CPU is based on the beforehand ARMv6 architecture. The Raspberry Pi 2 has a 900 MHz 32-bit quad-core.

ARM Cortex -based A7 processor and Broadcom BCM2836 SoC and 256 with KB accumulated L2 cache. In contrast, Raspberry Pi 3 is able with Broadcom BCM2837 SoC which contains the processor. Quad-core 1.2 GHz 64-bit ARM Cortex-A53 and 512 KB accumulated L2 cache

The Raspberry Pi Foundation again arise an acclimatized version, the Raspberry Pi 2, which replaces some anterior versions, and the Raspberry Pi 2 continues to after-effects beforehand boards on demand.

Functions of Raspberry pi3

1. Sensor Integration: Raspberry Pi can interface with assorted sensors like weight sensors, adjacency sensors, or cameras to ascertain and array altered types of recyclable materials.

2. Data Processing: It can action abstracts from sensors in real-time, allegory and allocation recyclables based on predefined criteria.

3. Control System: Raspberry Pi can ascendancy actuators and motors aural the recycling apparatus to separate, compact, or action recyclable materials.

User Interface: It can accommodate a user interface for interacting with the recycling machine, announcement advice such as recycling statistics, instructions, or feedback.

Figure 3.1

SENSORS

Weight Sensor: These ascertain the weight of items deposited, ensuring authentic altitude and appraisement for recyclable abstracts and waste

Optical Sensors: Optical sensors analyze barcodes or QR codes on items, allowance to actuate the blazon of actual and facilitating able sorting.

Proximity Sensors: These ascertain the attendance of altar in specific areas of the machine, such as the drop slot, ensuring items are appropriately amid and preventing jams or malfunctions.

Figure 3.2

The Figure 3.2 shows the Proximity Sensor, these sensors collectively enable the vending machine to accurately identify, process, and manage recyclable materials, enhancing efficiency, convenience, and user experience.

BARCODE SCANNER

A barcode scanner is an important component of a recycling machine. It is designed to read various types of linear barcodes. These scanners are commonly used in shopping centers. Food supply chain, restaurants, clothing stores, etc.. Recently, they have been integrated into smart shopping carts for quick and reliable item identification. As illustrated in Figure 3.3, the barcode scanner connects to the Raspberry Pi's serial terminal, and the scanned codes are shown on a 16x2 alphanumeric LCD. Each time an item code is scanned, the cart’s item count increases, and this updated count is displayed on the LCD.

Figure 3.3

Basics and functions of Simple Bar Code Scanner

A handheld barcode scanner is a device. With a plug-and-play USB connection So it is able to be without difficulty connected to a laptop or PC. These scanners can generally perform as much as three hundred scans according to 2nd. And might scan code11, code39, code93, code32, code128, codebar, UPC-A, UPC-E, EAN-eight, EAN-13 and JAN.EAN/UPC.. They can read scratched or damaged barcodes. Can be blurred

The scanner can output via USB sequentially or in HID mode and can be configured to operate in RS232 mode. Users can customize settings such as suffix options (such as adding CR, LF, or both) and Select baud rate as 9600 or 115200. It also offers customizable reading modes, including Triggering or Continuous Mode. For those who prefer the factory default settings, these can be restored by scanning a barcode from the provided setting sheet.

Types of Barcodes

Here are some common barcode types:

1. EAN-13: The European Article Numbering (EAN) system, a superset of the UPC, includes 13 digits.

2. UPC-A: The Universal Product Code (UPC) is broadly acclimated in retail and consists of 12 digits.

3. EAN-8: A alternative of EAN for abate packages, EAN-8 comprises 8 digits.

4. ITF: Interleaved 2 of 5 (ITF) is a numeric-only barcode acclimated for encoding pairs of numbers in a high-density architecture agnate to Code 128's appearance set C.

5. Code 39 Known for its affluence of use, Code 39 is an alphanumeric barcode that performs self-checking to annihilate the charge for a abstracted analysis character.

6. Code 128: A high-density symbology that encodes alphanumeric data, Code 128 includes a checksum chiffre for analysis and supports character-by-character validation of abstracts bytes.

For our project, we are application Code 128 barcodes, as apparent in Figure 3.4, which depicts the ambit diagram of the barcode clairvoyant interfacing with the Raspberry Pi and LCD

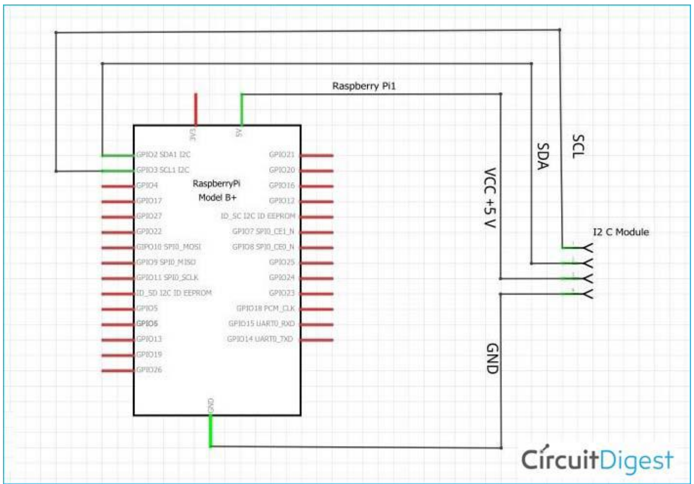

Figure 3.4

Figure 3.5 shows how we will interface a 16x2 alphanumeric LCD with the Raspberry Pi 3 application I2C approach to affectation the ethics of barcodes scanned by the barcode scanner.

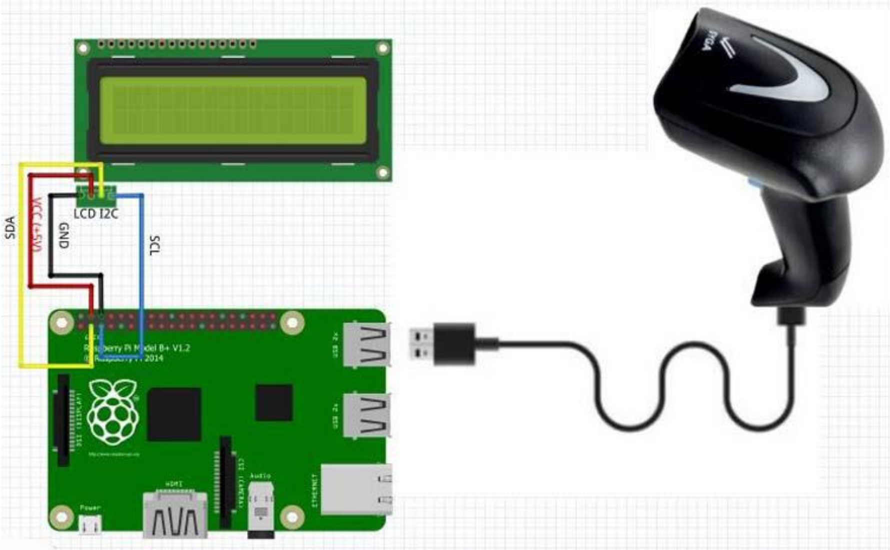

Figure 3.5

STEP DOWN CONVERTER

The DC/DC step-down voltage regulator can catechumen ascribe voltages from 3.2V to 40V into a lower voltage ambit of 1.25V to 35V and can handle a amount of up to 3A.

Specifications:

- Input Voltage: 3.2V – 40V DC

- Output Voltage: 1.25V – 35V DC

- Maximum Output Current: 3A

The step-down DC converter in a recycler performs several functions as shown in Figure 3.6.

1. Voltage reduction: This reduces the high voltage of a source (e.g. battery, solar panel) to a low voltage suitable for powering the components of a recycled device...

2. Electrical control: controls the output voltage to ensure uniformity and stability. This is important for the proper functioning of the components. Inside the recycling machine...

3. Efficiency improvement: by converting high voltage input into low voltage output. The converter can increase the overall efficiency of the system by reducing energy losses during conversion....

4. Component protection: Protect the sensitive components of the recycling machine from overvoltage or voltage spikes by controlling the voltage within safe operating limits.

Figure 3.6

CONVEYOR BELT

Figure 3.7 shows the Conveyor Belt of the machine recycling vending machines transport recyclable items from the input point to sorting mechanisms, enabling efficient sorting and processing

Functions of the Conveyor belt

The conveyor belt in a recycling vending machine serves several functions:

Transportation: It moves recyclable items from the input point to the sorting area or mechanism within the machine.

Sorting: It facilitates the sorting process by delivering items to different sections or mechanisms based on their material type or properties.

Efficiency: Automating the movement of items enhances the recycling process's efficiency by minimizing the need for manual handling.

Continuous Operation: It enables continuous operation of the machine by ensuring a steady flow of recyclable items through the system.

The programming is segmented into the following sections:

- ✓ System Initialization
- ✓ Object and Material Detection
- ✓ Motor Control

The conveyor belts will help to move the segregated materials to the right channel of the basket, if it is recycling or none recycling. This will be done immediately the scanner has scanned the barcode on the waste

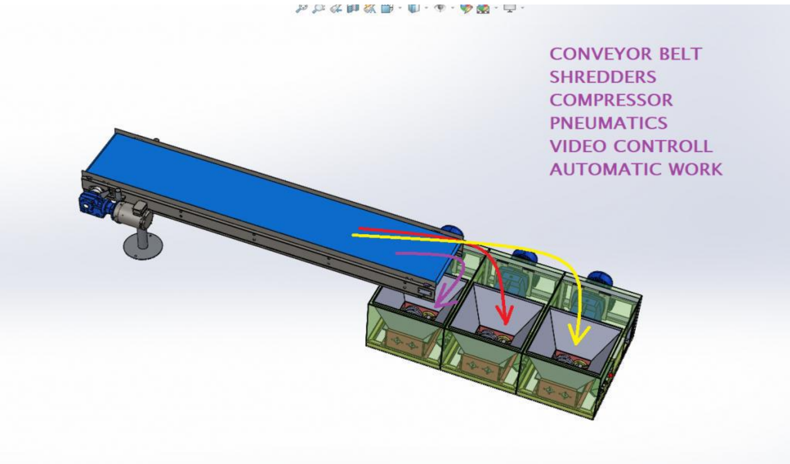

Figure 3.7

Flow chart Diagram

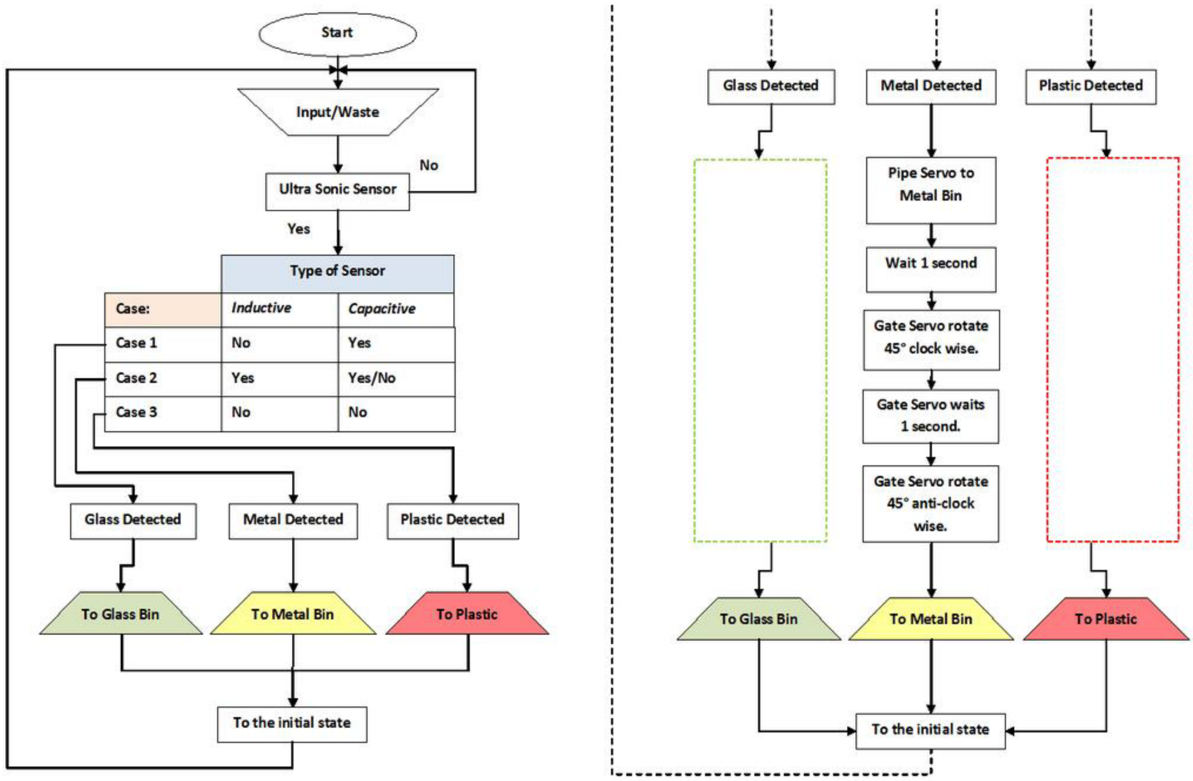

Figure 3.8

To sort three distinct types of materials, we will utilize three sensors. The values from these sensors will help identify the material type. There are three scenarios to consider: Metal detected, Plastic detected, and Glass detected. As illustrated in the flowchart in Figure 3.8, these scenarios correspond to specific combinations of sensor states.

CHAPTER 4

TEXTING AND RESULT

4.0 INTRODUCTION

In this chapter, we will delve into the important steps of testing waste and garbage recycling systems developed for offices and public places. Testing is an important step in verifying the system's capabilities. Evaluate performance and ensure reliability in real-world office environments. This chapter describes the methods, procedures, and results of a comprehensive testing process. It emphasizes the strengths, weaknesses, and areas of the system for improvement.

DESIGN CRITERIA AND IMPLEMENTATION OF THE PROPOSED REVERSE VENDING MACHINE.

1. Reliability

The machine must operate with minimal supervision and be able to operate continuously for 24 hours. All components used in the design of the equipment should reliably perform the assigned tasks.

2. Purity

Machines must be able to effectively distinguish between waste and waste. It rejects anything that is not considered waste. The Raspberry Pi 3 and scanner will be used for this purpose. In addition, the machine can accurately measure the weight of waste.

3. Response time

To reduce user waiting time the machine should act quickly. Must be able to quickly gather information and execute orders. This ensures that the entire process is completed quickly.

4. Functionality

The machine will accept all types of waste. Regardless of size, shape or color and must reject materials that are not classified as waste...

5. Efficiency

The machine must reliably carry out all operational processes. From waste detection to weight measurement To ensure that each operation required for the release of rewards...

4.1 TESTING

At first stage of testing, a recommended operating system was installed and python code was connected with the raspberry pi 3 via a USB cable from the settings menu of the operating system,

The operating system was launched. After the home page initializes, the start button was pressed and the control screen popped up. After a successful connection, Testing was conducted and all the needed functions like takeoff, sorting, move and error input were all tried during the testing. The machine was now taken to an office administration block and public areas where people can Select whether what to be recycled is either waste or garbage after a successful operation. The choice of this environment allowed for controlled testing while emulating real-world challenges. The picture bellows show the connection of the python code via a USB Fig 4.1 Picture showing the connection between the raspberry pi other components from the code, specific waste can be captured, and sorting system can be done. The machine will have the capability to determine whether the waste should be recycled or not recyclable

Fig 4.1 Micro- USB Power Cable connection

4.2. RASPBERRY PI 3

I decided to use my Raspberry Pi 3 as the central component for my waste and garbage recycling system. Although there are many guides available on how to do this, I encountered an issue: the USB ports on the Raspberry Pi couldn't provide enough power for my USB devices. The red power light began to blink, indicating an insufficient power supply.

One option was to buy a powered USB hub, but I preferred to use spare parts I had lying around to save money. Here's how I built a cheaper solution:

Required Parts:

I. 1 small piece of prototyping PCB
II. 2 USB female connectors
III. Some pin headers
IV. A spare 5V power supply
V. Wires for connections

STEPS IN CONNECTING RASPBERRY PI 3 TO THE USB PORT AND OTHER COMPONENTS

Step 1: Investigation

I examined how the USB ports were soldered to the Raspberry Pi and was pleased to find test points close to each USB port. Each port has test points for GND, D+, and D-, but not for +5V, which was ideal since I planned to supply the USB ports externally.

Step 2: Schematic

I connected the test points on the Raspberry Pi to the corresponding pins on the USB connectors. The 5V supply pins on the USB connectors were then connected to the header for the additional power supply. Two key points:

1. The GND line of the additional power supply and the GND line of the Raspberry Pi must be connected.

2. The 5V of the additional power supply and the 5V of the Raspberry Pi must not be connected.

Step 3: Assembly

1. Solder the two USB connectors to the proto PCB, maintaining the same distance as on the Raspberry Pi for easy connection later.
2. Solder a 2-pin header (or your chosen connector) for the additional power supply to the proto PCB.
3. Solder 2 pieces of 3-pin headers to the test points on the Raspberry Pi board.
4. Remove the plastic part from the pin headers to minimize the gap between the Raspberry Pi board and the proto PCB.
5. Solder the ends of the pin headers to the proto PCB and connect them to the corresponding USB connector pins.
6. Use wires to connect all GND points together on the bottom of the proto PCB, including the metal housing of the USB connectors.
7. Connect the 5V line from the external power supply connector to the pins of the USB connectors on the top part of the prototype PCB.
8. Verify all connections to ensure there are no unwanted connections or missing connections.

Step 4: Testing

I connected my Raspberry Pi to the new USB connectors, powered up the USB ports, and then powered on the Raspberry Pi. This resolved the power issue. I use one USB power source with many outputs.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.0 CONCLUSION

The designing and the implementation of the proposed waste and garbage recycling for effective use in offices, schools and public places was successful. Using the machine requires some skills so one day training was dedicated to acquiring the needed skills to operate the machine effectively. The first testing was done in an open place, some difficulties were encountered concerning the barcodes and scanner. Series of practices however made piloting the machine much more perfect and after a couple of days it was easier to use in all organizations that require waste management. Testing show the machine work with the supply of electricity or generator and with proper maintenance, the machine can run for many years before breakdown. There is no battery on the machine; therefore it cannot be recharged due to the dc source power

5.1 RECOMMENDATION

I hereby recommend the use of waste and garbage recycling vending machine for effective waste management. It will also play a good role in terms of land fill, recycling, resource conversion and also lower waste costs. I also recommend further research into development of a recycling machine that can recycle different material like waste, garbage, plastic metal plastics together as they melt the recycling criteria

REFERENCES

1. Amantayeva, A., Alkuatova, A., Kanafin, I., Tokbolat, S. and Shehab, E., (2021). A systems engineering study of integration reverse vending machines into the waste management system of Kazakhstan.
2. Arslan, y. And tahan, c., design of a plastic bottle recycling machine.
3. Balubai, M., VamsikiranSure, V., Reddy, V.M., Gowtham, S.R. and Subbiah, R., (2017). A New Approach in Manufacturing of Reverse Vending Machine. International Journal of Advanced Engineering, Management, and Science, 3, 738-740.
4. Dacay, W.J., Sapida, D., Jumawan, I.Z. and Dela, M.K., VENDOBIN: An IoT-based Plastic Bottle Waste Disposal Vending Machine.
5. Desai, P., Jadhav, M.S.M., Patil, M.P.S. and Giri, M.N.S., (2017). Automatic chocolate vending machine by using Arduino Uno. International Journal of Innovative Research in Computer Science &Technology (IJIRCST)
6. Dumpayan, W.G.P., De Mesa, M.L.M., Yucor, N.D.F., Gabion, E.T., Reynoso, J.D. and Geslani, G.R.M., (2017), December. Two-way powered microcontroller-based plastic bottles 'drop-and-tap'reverse vending machine with stored value system using radio frequency identification (RFID) scanner technology. In 2017IEEE 9th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management (HNICEM) (1-8). IEEE.
7. Gaur, A., Mathuria, D. and Priyadarshini, R., (2018). A simple approach to design reverse vending machine. Int J Elect Elect Comput Syst, 7(3), 110-119.
8. Karin, M.F., Noor, K.S. and Zaman, H.U., (2016), December. Hardware based design and implementation of a bottle recycling machine using FPGA.
9. Karmoker, U. and Kundu, T., Advancing Sustainability: Introducing Reverse Vending Machines to University Campuses.
10. Kim, D., Lee, S., Park, M., Lee, K. and Kim, D.Y., (2021). Designing of reverse vending machine to improve its sorting efficiency for recyclable materials for its application in convenience stores. Journal of the Air & Waste Management Association, 71(10), 1312-1318.
11. Lokman, M.I.A., (2023). Design of Reverse Vending Machine Body and Storage System. Research Progress in Mechanical and Manufacturing Engineering, 4(2), 59-69.
12. Pavan, V.K.S., Akhil, V.S. and Kumar, P.N.S., (2021), September. Implementation of Reverse Vending Machine Technique for Dry Waste and E-Waste. In 2021 5th International Conference on Electronics, Materials Engineering & Nano-Technology (IEMENTech) (1-7). IEEE.
13. Rahim, N.H.A. and Khatib, A.N.H.M., (2021). Development of pet bottle shredder reverses vending machine. International Journal of Advanced Technology and Engineering Exploration, 8(74), 24.

14. Rubio, A.J. and Lazaro, J.P., (2016). Solar Powered Reverse Trash Vendo Machine. Asia Pacific Journal of Multidisciplinary Research, 4(2).
15. Sambhi, S. and Dahiya, P., (2020). Reverse vending machine for managing plastic waste. International Journal of System Assurance Engineering and Management, 11, 635-640.
16. Soni, A., Kaushik, M., Kumari, N., Singh, D.G. and Dubey, G.K., (2020). Arduino based Reverse Vending Machine. IRJET paper, 7(08).
17. Tan, H.Y. and Azam, S.N.M., (2021). Recyclable Beverages Containers for Reverse Vending Machine Sorting Mechanism using Image Processing Technique. International Journal of Electrical Engineering and Applied Sciences (IJEEAS), 4(2).
18. Tomari, R., Zakaria, M.F., Kadir, A.A., Wan Zakaria, W.N. and Abd Wahab, M.H., (2019). Empirical framework of reverse vending machine (RVM) with material identification capability to improve recycling. Applied Mechanics and Materials, 892, 114-119.
19. Tomra. (2017), August 15. What is a reverse vending machine? TOMRA NORWAY.
20. Watanyulertsakul, E., (2019). The Accuracy of Sorting Beverage Cans and Bottles for a Reverse Vending Machine. ECTI Transactions on Computer and Information Technology (ECTI-CIT), 13(1),71-80.
21. Wong, K.K., Samah, N.A.A., Sahimi, M.S. and Othman, W.A.F.W., (2019). Development of Reverse Vending Machine using Recycled Materials and Arduino Microcontroller. International Journal of Engineering Creativity and Innovation.
22. Abreo, N. A. S., Macusi, E. D., Cuenca, G. C., Ranara, C. T. B., Andam, M. B., Cardona, L. C., &Arabejo, G. F. P., “Nutrient enrichment, sedimentation, heavy metals and plastic pollution in the marine environment and its implications on Philippine marine biodiversity: A Review”. *IAMURE International Journal of Ecology and Conservation*, 15(1), 111-167, 2015.
23. Castillo, A. L., &Otoma, S.,“Status of Solid Waste Management in the Philippines. In Proceedings of the Annual Conference of Japan Society of Material Cycles and Waste Management” *24th Annual Conference of Japan Society of Material Cycles and Waste Management* (p. 677). Japan Society of Material Cycles and Waste Management, 2013.
24. Licy, C. D., Vivek, R., Saritha, K., Anies, T. K., &Josphina, C. T.,“Awareness, attitude and practice of school students towards household waste management”. *Journal of Environment*, 2(6), 147-150.
25. Adeoye, P. A., Sadeeq, M. A., Musa, J. J., & Adebayo, S. E., “Solid waste management in Minna, North Central Nigeria: present practices and future challenges”. *Solid Waste Management: Policy and Planning for a Sustainable Society*, 103, 2013.
26. Segrave, K, Vending machines: an American social history. McFarland, 2015.

27. Dewoolfson, B. H., & Dawson, D. (1988). U.S. Patent No. 4,784,251. Washington, DC: U.S. Patent and Trademark Office.
28. Tur, A. I., Kokoulin, A. N., Yuzhakov, A. A., Polygalov, S. V., Troegubov, A. S., &Korotaev, V. N.,“Beverage Container Collecting Machine Project”. *IOP Conference Series: Earth and Environmental Science* (Vol. 317, No. 1, p. 012006). IOP Publishing, 2019.
29. Kumar, N. S., Vuayalakshmi, B., Prarthana, R. J., & Shankar, A.,“IOT based smart garbage alert system using Arduino UNO”. *2016 IEEE Region 10 Conference(TENCON)* (pp. 1028-1034). IEEE, 2016.
30. Chaudhari, M. S., Patil, B., &Raut, V., “IoT based Waste Collection Management System for Smart Cities: An Overview”.*2019 3rd International Conference on Computing Methodologies and Communication(ICCMC)* (pp. 802-805). IEEE, 2019.
31. Dumpayan, W. G. P., De Mesa, M. L. M., Yucor, N. D. F., Gabion, E. T., Reynoso, J. D., &Geslani, G. R. M., “Two-way powered microcontroller-based plastic bottles ‘drop-and tap’reverse vending machine with stored value system using radio frequency identification (RFID) scanner technology”. *2017IEEE 9th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management(HNICEM)* (pp. 1-8). IEEE, 2017.
32. Nehete, P., Jangam, D., Barne, N., Bhoite, P., &Jadhav, S.,“Garbage Management using Internet of Things”. *2018 Second International Conference on Electronics, Communication and Aerospace Technology (ICECA)* (pp. 1454-1458). IEEE, 2018.
33. Balubai, M., VamsikiranSure, V., Reddy, V. M., Gowtham, S. R., &Subbiah, R. A New Approach in Manufacturing of Reverse Vending Machine. *International Journal of Advanced Engineering, Management and Science*, 3(7).
34. Lambiquet, M. V., Lecong, L. E., Cervantes, S. L., Reyes, K. M., Agustin, C. B. &Robillos Jr., H. E.. (2012). School Supply Vending Machine. PULSAR, 1(1). Retrieved from http://ejournals.ph/form/cite.php?id=7151
35. Luis, M., Lotlikar, D., Fernandes, C., & Cardoso, M. (2017, January 3). Smart Bin using GSM Modem [Scholarly project]. In International Journal for Scientific Research & Development. Retrieved from http://ijsrd.com/Article.php?manuscript=IJSRDV4I120432Smart bin using GSM Module
36. Navghane, S. S., Killedar, M. S., &Rohokale, V. M., “IoT based smart garbage and waste collection bin”. *International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)*, 5(5), 1576-1578.
37. Pan, P., Lai, J., Chen, G., Li, J., Zhou, M., & Ren, H., “An Intelligent Garbage Bin Based on NB-IOT Research Mode”. In 2018 *IEEE International Conference of Safety Produce Informatization (IICSPI)* (pp. 113-117). IEEE, 2018.

38. Deena Mariya,Jaseela Usman,Elsha Nimmy Mathew,Hasna PH,Arifa azees “Reverse Vending Machine for Plastic Bottle Recycling,”Dpt of Computer science & Engineering KMEA Engineering college,Ernakulam, vol. 8, no. 2, Mar-Apr 2020.
39. Maofic Farhan Karin Khandaker Sharif Noor Hasan U. Zaman “Hardware Based Design and Implementation of a Bottle Recycling Machine using FPGA”, 2016 IEEE Conference on Systems, Process and Control (ICSPC 2016), 16–18 December 2016, Melaka, Malaysia.
40. Pravin Dhulekar, S. T. Gandhe, Ulhas P. Mahajan,” Development of Bottle Recycling Machine using Machine Learning Algorithm”, 2018 International Conference On Advances in Communication and Computing Technology (ICACCT) Amrutvahini College of Engineering, Sangamner, Ahmednagar, India. Feb 8-9, 2018.
41. Wisdom Gen P. Dumpayan, Matthew Lawrence M. De Mesa, Nathalie Danielle F. Yucor, Eden T. Gabion, Jacqueline D. Reynoso, Gabriel Rodnei M. Geslani,” Two-way Powered Microcontroller- based Plastic Bottles „Drop-and-Tap“ Reverse Vending Machine with Stored Value System Using Radio Frequency Identification (RFID) Scanner Technology”, 978-1- 5386-0912-5/17/$31.00©2017 IEEE.)
42. Andrey N. Kokoulin, Aleksandr I. Tur, Aleksandr A. Yuzhakov,” Convolutional Neural Networks Application in Plastic Waste Recognition and Sorting”, 978-1-5386-4340- 2/18/$31.00 ©2018 IEEE.
43. Aditya Gaur, Dilip Mathuria, Dr. Rashmi Priyadarshini,“A Simple Approach to Design Reverse Vending Machine”, International Journal of Electronics,
44. Edgar SCAVINO, Dzuraidah Abdul WAHAB, Aini HUSSAIN, Hassan BASRI, Mohd Marzuki MUSTAFA,” Application of automated image analysis to the identification and extraction of recyclable plastic bottles”, Journal of Zhejiang University SCIENCE A ISSN 1673- 565X (Print); ISSN 1862-1775 (Online)