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A Review on Reverse Vending Machine

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Abstract: In this project, a reverse vending machine (RVM)-inspired automatic recycle bin with a reward element is proposed. The device is essentially built in a regular recycle bin that is fitted with a microcontroller and a variety of sensors. The sensors in charge of identifying user information are used throughout. The code will appear on the LCD once the process is finished. The user must scan the QR code that is printed on the device in order to redeem their points.

Keywords: component, formatting, style, styling, insert

I. INTRODUCTION

Reverse vending machine (RVM) use has been rising steadily in recent years. When waste is disposed of, dangerous gases are released. Effective trash management is one of the most crucial steps in the recycling process. A motivating and effective method of rubbish collection is the reverse vending machine (RVM). There are numerous varieties of vending machines on the market, and we categorise them according to how much money they produce. One sort of item can only be produced by the first vending machine, which is based on single selection. The second type is based on double selection and provides the customer with two separate output item categories, such as coffee, cold drinks, tea etc. Reverse vending machines are distinguished in a similar way based on this. In order to replicate the Reverse Vending Machine (RVM), Capacitive Proximity Sensors, and Inductive Sensor, we made a strategy. The goal of the reverse vending machine simulation (RVM) is to efficiently manage waste for recycling purposes and reduce pollution. The user enters plastic or metal objects into the proposed reverse vending machine after it has begun to operate. Reverse vending machines may soon be installed in public spaces such as subways, train stations, colleges, and public buildings.

II. LITERATURE REVIEW

Noor Hasyimah Abu Rahim et.al.,[1]: The construction of a reverse vending machine (RVM) with bottle-crushing capabilities to destroy polyethylene terephthalate (PET) bottles is discussed in this paper. The PET bottles that are returned are cut into smaller pieces to be used in the future recycling process. Capacitive sensors that can identify bottles are part of the hardware, along with LCD status displays and an Arduino UNO controller for all key Customers will receive compensation based on the quantity of empty PET bottles they feed into this PET shredder RVM, which can shred standard-sized PET bottles. Huma Zia et.al.,[2]: In this study, To collect, identify, categorize, and sort old plastic bottles, they developed a low-cost incentive-based RVM with a reward-based user application. The created RVM is made up of sensors, a camera, a low-cost computer running a self-designed mechanical arm and a straightforward image processing algorithm. To support the RVM's basic computing setup, a lightweight MobileNet model has been trained via transfer learning.

Yunchao Tang, Ming Zhu et.al.,[3]: Nine recycled aggregate concrete-filled steel tube columns (RACSTCs) and one conventional concrete-filled steel tube contrast column each underwent low cycle reciprocating load tests for this investigation (OCSTC). The characteristics of interest of steel tubes were thought to be the wall thickness and axial compression ratio. The failure mechanism, energy consumption performance, skeleton curve, stiffness degradation, ductility coefficient and hysteresis performancewere investigated in order to compare the two types of columns.

Fadlil A, Umar R et.al.,[4]: CNN (Convolutional neural networks) and SVM (support vector machines) are common techniques used in this study for this instance. The data training procedure used by the two strategies to accomplish categorization goals differs. Although there are some distinctions between both strategies, both provide some benefits. In order to evaluate the two CNN and SVM methodologies, this study examines the training methods that were employed and the classification accuracy results. Pre- processing, training, and testing are the different process stages. Ten used objects are medium-sized, unbranded trash plastic bottles with a total of 1100 pictures. Both methodologies offer benefits and drawbacks in the data training and classification processes, according to the observations.

Zhenxing Cai, Yang J et.al.,[5]: The implementation of a multi-scale feature fusion method for hyperspectral images and RGB based on Segmenting Objects by Locations enhances the identification of transparent polypropylene (PP), transparent polyethylene terephthalate (PET), blue PET bottles on a black conveyor belt (RHFF-SOLOv1). To acquire RGB and hyperspectral images simultaneously, a

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Near-infrared (NIR) hyperspectral camera and a line-scan camera are used, whose spectral is ranging from 935.9 nm to 1722.5 nm. Additionally, we offer a method as the features of the hyperspectral image that greatly reduces dimensionality by selecting the bands from 1087.6 nm to 1285.1 nm. The findings demonstrate that the suggested fusion approach outperforms the SOLOv1 method in terms of classification accuracy for plastic bottles, with an overall accuracy of 95.55%. Last but not least, RHFF-SOLOv1 which results in accuracy of 97.5% in blue bottle categorization, outperforming the majority ofearlier space-spectral fusion approaches.

Qiang Zhang, Qifan Yang et.al.,[6]: In this study, a transfer learning-based DenseNet169 trash picture classification model is proposed. The trash picture dataset NWNU- TRASH is created as a result of the drawbacks of the existing public waste dataset, including its unequal data distribution, single background, glaring features, and short sample size of the waste material image. The dataset benefits from a balanced distribution, a high level of diversity, and a rich background, which is better inaccordance with actual demands. 70% of the dataset is madeup of the training set, while 30% is made up of the test set. Based on the pre-trained DenseNet169 deep learningnetwork model, we may build a DenseNet169 model that is suitable for this experimental dataset. The experimental results in the DenseNet169 model's categorizationation accuracy is about 82% after transfer learning.

Piotr Nowakowski, Teresa Pamuła et.al.,[7]: The proposed solution can be used with a mobile app or a server. A unique approach of classification and identification utilising neural networks is suggested to categorise and identify the type of e-waste from the photos. To quickly determine the type and amount of the waste equipment from the photos, a quicker region-based convolutional neural network (R-CNN) was deployed. The selected e-waste categories have recognition and classification accuracy ranging from 90 to 97%. E- waste collection firms can create a collection plan by allocating an adequate number of trucks and payload capacity for a particular e-waste project once the size and type of the garbage are automatically detected and sorted from the provided photographs.

S.C. Athukorala, H.M.A.L. Hennayaka et.al.,[8]: The reverse vending machine is designed with a plastic sorting function is the main topic of this article for usage in Sri Lanka. After reviewing the existing systems, a solution that uses gravity transfer and near-infrared (MR) plastic sorting was developed. Moreover, a suitable rewarding system is also suggested.

AN Kokoulin et.al.[9]: This article looked at certainmethodologies in computer vision and image processing andhow they applied to the problems of automatic fraud detection and automated detection of empty containers for recycling. Due to the memory and computational limitations of SoC and IoT controllers, the list of possible methods and frameworks was shortened.

W.G. P. Dumpayan, M. L. M. de Mesa et.al.,[10]: The microcontroller in this project serves as the brains of the system, controlling the numerous input i.e. sensors and keypadand output devices i.e. display and motors that are connected to it. Plastic bottles are accepted by the machine, which converts them into points that can be used to purchase goods. The machine's operation demonstrated accuracy in identifying RFID accounts, determining whether bottles were plastic or not, storing or updating points for each account, and dispensing goods. The device may operate using either utility electricity or solar power.

Razali Tomari, Aeslina Abdul Kadir et.at.,[11]: In this project, a reverse vending machine (RVM)-inspired automatic recycle bin with a reward element is proposed. The sensors are in charge of recognising user data, weighingthe scale, and ultimately automatically converting theweight to the correct points. The user can use their RFID point card to collect their points once the process is complete.

Maofic Farhan Karin et. al.[12]: In In this paper the designof a Smart Bottle Recycle Machine (SBRM) is presented. It uses an ultrasonic range sensor, which is easily accessible and reasonably priced, and is designed on a Field Programmable Gate Array (FPGA). The sensor was used to count the bottles and identify each one individually. The primary goal of this project is to produce an SBRM at a lower cost. On an Altera DE2-115 board, this project was implemented using Verilog HDL. With this prototype, users may recycle plastic bottles while also collecting rewards. In contrast to the latter, which can only accomplish a limited amount of parallel processing, the former can quickly complete multiple simultaneous processes at the same time.

Ana Monga et.al.[13]: This paper discusses the FPGA-based implementation of a reverse vending machine. The procedure upon which RVM is built involves the machine accepting any empty containers that are still there and producing according to the quantity of containers. RVM is supported in this paper by empty containers, cash, nibbles, chocolate, cold beverages, etc. The Xilinx FPGA Spartan3 development board is used to model the algorithm and implement it in VHDL.

S. B. Z. Azami and M. Tanabian et.al.,[14]: This paperdiscusses a mobile payment method where the vending machine doesn't need a connection and where infrared is used for local communication (IR). By using IR to identify the cell phone, the vending machine will be able to communicate with it by sending a message to the back-end server. The transaction data can be supplemented with comprehensive inventory and telemetric data. The back-end server decodes the message, processes the transaction, handles billing, and sends inventory data to the vending machine operators.

Wahab M, Kadir A et.al.,[15]: In this article, we presentedan application for smart recycle bins that uses data from smart cards to automatically determine the weight of waste, convert that weight to points, and then store those points on

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the card. Garbage tracking smart bins that use an integrated web-based information system from the host server and an RFID-based system. This method can enhance two key aspects of the selective sorting procedure. The application of material waste classification is first aided by the user. The smart bin can also communicate with the rest of the recycling chain because it is aware of its own contents.

Xinwen Chi, Martin Streicher-Porte et.al.,[16]: Paper recycling is a cutting-edge and increasingly popular low- cost recycling approach for managing discarded electronic and electrical equipment.This study compiles data on unofficial e-waste management. Existing informal sectors

should be considered in new formal e-waste recycling systems, and more policies are required to raise recycling rates, working conditions, and the effectiveness ofall associated informal players.

III. SYSTEM OVERVIEW

Capacitive proximity sensor and inductive proximity sensor are the two major sensors in the system. Figure 1 depicts an illustration of the Reverse Vending Machine's whole scenario.

Fig 1.Reverse Vending Machine

The components used to implement the proposed Reverse Vending Machine are as shown below

A. Proximity Sensors

1. Inductive Proximity Sensor

An electromagnetic radiation-based sensor called an inductive proximity sensor detects metal targets without making direct touch with them. An inductive proximity sensor's detection range can vary depending on the kind of metal being detected. Because non-metallic substances like dirt and moisture do not block detection, inductive proximity sensors function in damp or filthy environments.

Fig 2. Inductive Proximity Sensor

2. Capacitive Proximity Sensor

The Sensing equipment called capacitive proximity sensors (CPS) is used to find nonmetallic targets. They can pick up lightweight or small items that mechanical limit switches cannot. CPS are perfect for sensing powdered or granular material, liquid level control, plastics and other nonmetallic targets.

Fig 3.Capacitive Proximity Sensor

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B. SG90-Micro Servo Motor

An extremely small and light server motor, the micro servo Motor SG90 has a high output power. Servo motors, also referred to as servos, are independent electric apparatuses used to accurately push or spin machine components. The waste bin lid has an automated mechanism thanks to a servo motor. A perfect angular or linear position can be perfectly maintained by this rotary or linear actuator. It may turn in either direction up to 90 degrees. (both anticlockwise and clockwise). The placement of the servo motor (SG90) enables the garbage can lid to be automated. If waste is found, the lid will automatically open; if it is full, it won't open and a message is sent to the appropriate authorities asking them to collect the waste.

Fig 4. SG90- Servo Motor

C. Alphanumeric LCD

An LCD (Liquid Crystal Display), a form of flat panel display, relies heavily on liquid crystals to function.Thedisplay system is an LCD (16 by 2). It is an output module with a 32-character per-line capacity. After placing the trashin the RVM, the LCD is used to display the code.

Fig 5. LCD Display

D. Ultrasonic Sensor

Due to the fact that the shape of the item has no bearing on how the sound wave is reflected, ultrasonic sensors are very effective at measuring amplitude. This is the primary justification for choosing this sensor to assess waste level. This sensor uses an ultrasonic sound transmitter and receiveroperating at room temperature to measure an object's distance from 2 cm to 400 cm within a 15° angle.

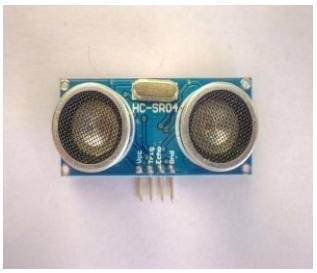

Fig 5.Ultrasonic Sensor

E. GPS Module

The GPS (Global Positioning System) is based on satellite navigation system that provides the information of position and timing. Tiny processors and antennas included in GPS modules use certain RF frequencies to directly receive data from satellites. Then, it will gather all the data from many sources, includes timestamps from all observable satellites.If the antenna module can identify four or more satellites, it can determine its time and location accurately. For tracking or determining location, GPS receivers are typically utilised in cellphones, fleet management systems, military equipment, etc. The GPS (Global Positioning System) isbased on satellite system that uses satellites and groundstations to calculate and determine its position on Earth.

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Fig 5.GPS Module

F. Arduino Mega 2560

The Arduino Mega 2560 microcontroller board is built on the ATmega2560 (datasheet) and act as base for it.It has 54 digital input/output pins, out of 54 pins, 14 pins can be usedas PWM outputs, 16 pins as analogue inputs, 4 hardware serial ports (UARTs), a 16 MHz crystal oscillator, a reset button, a USB connector, a power jack, an ICSP header, and. The microcontroller comes with everything it needs to function; all that is needed to get it started is the insertion of an AC-to-DC adapter, a USB cable, or a battery. The majority of shields designed for the Duemilanove or Diecimila Arduino models work with the Mega as well. The Arduino Mega is replaced with the upgraded and advanced Mega 2560.

Fig 6. Arduino

G. NodeMCU

NodeMCU is a Lua-based firmware and an open-sourcedevelopment board which is designed specifically for Internet of Things (IoT) applications. Its firmware is powered by the ESP8266 Wi-Fi SoC from Espressif Systems and its hardware is based on the ESP-12 module. The user-friendly Arduino IDE makes it simple to programme the NodeMCU Development Board.

Fig 7. NodeMCU ESP8266 Breakout Board

IV. METHODOLOGY

A machine known as a "reverse vending machine"takes used beverage plastic and metal containers and gives cash back to the user (the reverse of the typical vending cycle). The gadgets are often used in regions with mandatory recycling rules or container deposit laws. The user can input containers one at a time using the horizontal in-feed method. In the fundamental procedures, the recycler inserts the empty bottle or can into the receiving aperture. Then, using capacitive and inductive proximity sensors, the bottle or can is automatically scanned. If the inductive sensor's sensor value is 1, the object is made of metal, and if the inductive sensor's sensor value is 0 and the capacitive sensor's sensor value is 1, the object is made of plastic.

Regarding the incentive program, RVM uses a Blockchain database to distribute priceless tokens like money or coupons. In contrast to traditional databases, a particular kind of shared database called a "block chain" stores data in blocks that are later joined via cryptography.

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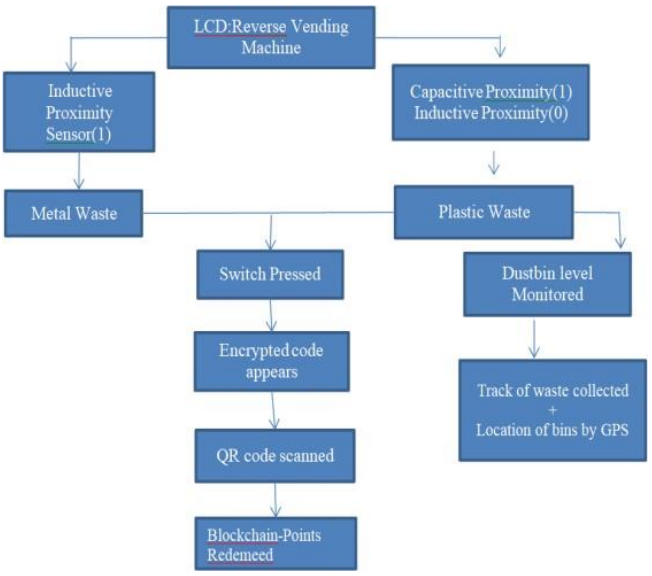
With the use of a block chain, digital information may be recorded and distributed without being edited. Because virtually no human interaction remains in the verification process, there is less chance of human error and the data is reliably recorded. Only one copy of the block chain would be impacted even if one of the network's computers made a computation mistake. The presents can then be redeemed at the counter using the coupons. Unfortunately, printing coupons is not a popular practice due to environmental awareness and the need to use less paper. So, in our suggested method, as soon as plastic isrecognized, an LCD panel displays an encrypted code. The user must then input the code he obtained from the LCD screen on the website, by scanning the QR code that is available on the machine the person can redeem his points. The user who has an account on the reverse plastic vending machine website has access to a database. To redeem the points for disposing of plastic, one must be logged in with an account. Themachine has one more advantage that is when the machine is full, an application notifies the trash handlers or recycle vendors. The machine's level is checked using an ultrasonic sensor and the global positioning system. When the machine is full, the collectors are notified and the precise location of the machine is sent.



V. SOFTWARE DEVELOPMENT

Arduino IDE:

The official software that was released by Arduino.cc is known as the Integrated Development Environment, or IDE. It is mostly employed for editing, assembling, and uploading code to Arduino hardware. This open source application, which is simple to install and use to start, writing code while on the road, is compatible with nearly all Arduino modules. There are numerous Arduino modules, including the Uno, Leonardo, Mega, Micro, and numerous others. Each of themhas a microcontroller on the board that can be programmed and accepts data in the form of code.

The IDE environment's two main parts are the Editor and Compiler. The necessary code is created in the Editor, then it is compiled and uploaded into the chosen Arduino Module using the Compiler. The languages such as C++ and C language are supported in the IDE environment.

IV. CONCLUSION

The ability to exist in a highly populated metropolitan region is gradually becoming more challenging due to the increased degree of trash output. Using a technology-based strategy to manage this rising level of waste is long overdue. Users receive points by typing the code on the internet into the Reverse Vending Machine, which contains a proximity sensor to distinguish between different bottle kinds. Thisinvention generally refers to trash management and recycling of environmental metal and plastic waste. A system that receives plastic and metal garbage for recycling and in exchange gives the worker who recycles the waste pints in their pocketbook is known as a smart machine for plastic and metal waste disposal.

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