AUTOMATIC WASTE SEGREGATING SYSTEM AND SMART BIN

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Abstract— Urban areas face challenges in waste management systems due to the rise of population in cities, causing an enormous amount of waste generation and traditional waste management system is highly inefficient, the waste resources will be utilized efficiently with the combination of the various sensors and deep learning models. The main purpose of this project is to develop a sensible segregation system for the welfare of the environment. This model uses the Arduino Uno as a central hub to regulate all the sensors. The trash bin monitors the waste fill percentage and opens or closes when the user is near or far away. A transporter (Conveyor belt) will be employed where the sensors are interfaced with a camera to identify the type of waste. Then the waste travels and gets into its respective bin, which makes segregation easier.

Index Terms—Garbage, Monitoring, Segregation, Bin

I. INTRODUCTION

After the start of industrialization and population growth, the management of biodegradable and non-biodegradable waste was a major problem due to the lack of proper human care and proper regulation. This leads to severe health issues for humans and animals, and other issues. Also, a limited amount of research has been conducted in this area. Therefore, a better segregating system is being proposed in this project, which makes the segregation more convenient and reduces the need for manual segregation. By using smart segregating bin, the management of waste can be improved without any major compromises, and proper hygiene can be maintained.

II. LITERATURE SURVEY

Nicholas Chiend Anak Sallangi and et. al. outlined a way for integrating the internet of things (IoT) and machine learning into the waste sorting process. For garbage classification and categorization, the SSD MobileNetV2 Quantized is employed and trained with a dataset that includes paper, cardboard, glass, metal, and plastic. Using the trained model on TensorFlow Lite and

Raspberry Pi 4, the camera module detects rubbish, and the servo motor coupled to a plastic board categorizes the waste into the appropriate waste container. The garbage fill percentage is monitored by an ultrasonic sensor, and the latitude and longitude are obtained in real-time by a GPS module. The smart bin's LoRa module transmits the bin's status to the LoRa receiver at 915 MHz. The smart bin's electronic components are protected by an RFID-based locker that can only be unlocked with a registered RFID tag for maintenance or upgrades.

The suggested system has several flaws. To begin with, the tiny dataset makes it difficult to enhance the CNN-based object detection model, which can only detect five categories of common garbage. Apart from that, the higher-precision object detection model cannot be implemented on the Raspberry Pi without the use of a GPU [1].

The goal of this study, according to Namratha A M and et al., is to develop a system that will assist in overcoming the obstacles and hurdles to trash management and segregation. The suggested automatic waste management and segregation system employs the Internet of Things (IoT) idea, with an embedded system that separates garbage and monitors bin levels. The state of the bins is communicated to the appropriate authorities, who are then notified to evacuate the bins, and the bins locations are tracked over the internet. This technology saves time and money by reducing human intervention and interaction. According to the city's population, the system requires a bigger number of rubbish containers for separate waste collection. As a result, the initial cost is significant. The memory size of the sensor nodes utilized in the dust bins will be limited [2].

Deep learning did not do well in the field of garbage picture categorization due to a lack of data for training. Therefore, Cuiping Shi and et. al. uses TrashNet dataset. The TrashNet data set, which is widely used in the field of rubbish picture classification, is used in this research to try to overcome data inadequacies in this sector by improving the network structure. Deeper networks and short-circuit connections, which are widely used in the field of deep learning, are found to be ineffective on the TrashNet data set.

This paper presents an effective strategy for improving network performance on the TrashNet data set by analyzing and altering the network structure. This method stretches the network by adding branches, then employs extra layers to achieve feature information fusion. At a little processing expense, it can make full use of feature information. The performance of the new network has been considerably enhanced by using this technology to replace the basic structure of the Xception network. Finally, on the TrashNet data set, the proposed M-b Xception network achieves 94.34 percent classification accuracy and has certain benefits over several state-of-the-art approaches on multiple indicators [3].

The design and execution of an automated solid waste sorting system are described in the work by Khaled Chahine and et. al. A programmable logic controller, an inductive proximity sensor, a capacitive proximity sensor, and a photoelectric sensor are all included in the designed system. Multi-sensor data fusion is used to ensure that each material produces a unique set of sensor outputs. Once a material has been detected, the controller causes a stepper motor to rotate at a predetermined angle, collecting the material in its designated bin. The system is successful in sorting the four different materials, according to the results of the tests. To get around the fact that there are no sensors that just detect wood, glass, or plastic, the system depended on multi-sensor data fusion initially, and then on the capacitive proximity sensor's range adjustment so that it doesn't detect plastic beyond a particular range [4].

In this paper an Automatic Waste Segregating System is proposed which is designed to minimize the disadvantages of the papers aforementioned and produce a stable system. The system incorporates several sensors to address the issue of a small dataset since data is gathered by sensors during the first development phase. This supports image processing in later stages. Also, the investment is not significant while leaving potential for future growth. Also, a waste bin is included to collect the waste while providing hands-free opening.

III. METHODOLOGY

The block diagram of the proposed smart bin is shown in the figure 1. It consists of Arduino Uno, LCD module, LED, Buzzer, Ultra-sonic sensor.

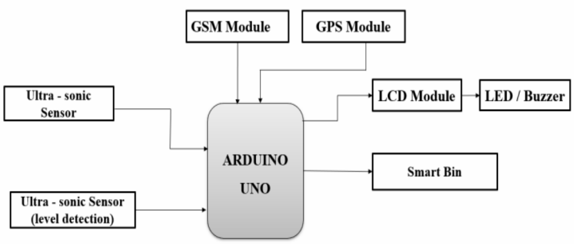

Fig 1. Smart bin

The operations take place in the smart bin are listed below:

• The opening and closing of bin using servo motor based on distance between user and bin.

• Level detection of bin using Ultrasonic Sensor.

• Doesn't open when the bin is full

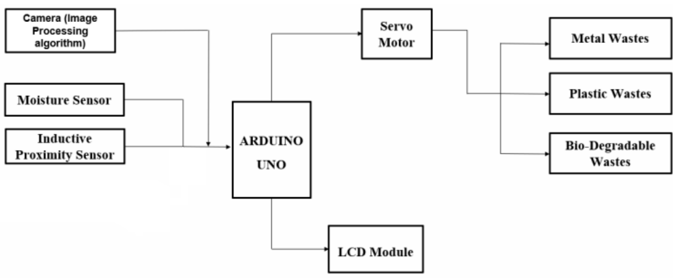

Fig 1.2 - Segregation system

The block diagram shown in the figure 1.2 consists of Arduino Uno, Conveyor belt, moisture sensor, inductive proximity sensor, LCD module, servo motor and camera for segregation process.

The waste is transferred through conveyor belt. As the waste move, it goes range of sensor detection. Those sensors use the data collected to segregate the waste.

IV. HARDWARE COMPONENTS

A. *Arduino Uno*

The Arduino Uno is a microcontroller board based on the ATmega328P 8-bit microcontroller. Along with the ATmega328P, it consists of other components like a crystal oscillator, serial communication, a voltage regulator, etc. to support the microcontroller.

The Arduino Uno features a USB interface, 6 analog input pins, and 14 digital I/O ports used to interface with external electronic circuits. Of the 14 I/O ports, 6 pins can be used for PWM output. It allows designers to control and detect external electronic devices in the real world.

B. *Inductive Proximity sensor*

The inductive proximity sensor detects the metallic object that is next to its active side. This sensor works on the electrical principle of inductance, in which a fluctuating current induces an electromotive force (EMF) in a target object. These non-contact proximity sensors detect ferrous objects, ideally mild steel over a millimeter thick.

C. Moisture sensor

This soil moisture sensor module is used to detect soil moisture. It measures the volumetric water content in the soil and gives us the moisture content as an output. The module has digital and analog outputs and a potentiometer for setting the threshold.

D. Ultrasonic sensor

The HC-SR04 Ultrasonic Sensor uses a sonar to determine the distance to an object. HC-SR04 is an ultrasonic distance module that provides non-contact measurement function from 2cm to 400cm. The distance accuracy can reach 3mm, and the effective angle is <15°.It can be powered by a 5V power supply. The configuration pin of the HC-SR04 is VCC (1), TRIG (2), ECHO (3) and GND (4). The VCC supply voltage is 5V and the TRIG and ECHO pins can be interfaced to any digital I/O on the Arduino board to power it.

E. IR Proximity sensor

This IR Proximity Sensor is a general-purpose infrared sensor that can be used for obstacle detection, color detection, fire detection, line detection, etc. and also as an encoder sensor. It is used in many robotic applications such as obstacle avoidance robots, line following robots and other obstacle detection projects. This is an active infrared sensor that emits and detects its own IR rays. A passive infrared sensor only detects IR rays emitted by objects. The PIR sensor is a good example of passive IR sensors.

F. Servo motor

A servomotor is a small device with an output shaft. This axis can be set to specific angular positions by sending a coded signal to the servo. As long as the encoded signal is present on the input line, the servo will maintain the angular position of the axis. As the encoded signal changes, the angular position of the axis changes. In practice, servos are used in radio-controlled aircraft to position control surfaces such as the elevator and rudder.

G. SSD MobileNet v3

MobileNetV3 is a convolutional neural network tuned to cellphone CPUs through a combination of hardware-aware network architecture search, augmented by the NetAdapt algorithm, and then enhanced by novel architectural advances.

V. RESULT AND DISCUSSIONS

A. Smart waste bin

The hardware used are Moisture sensor, Ultrasonic sensor, IR proximity sensor, Servo motor and LCD module had been connected to the Arduino UNO.

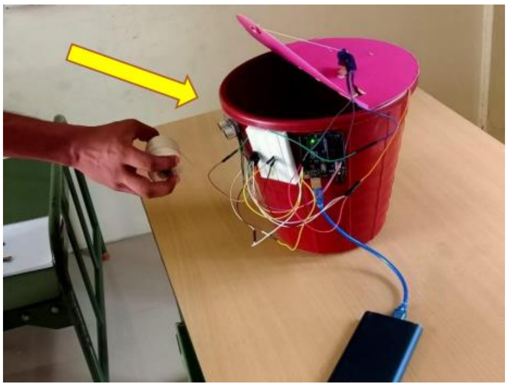

Fig 2.1- Smart bin

The smart bin is shown in the fig 2.1, it is made up of an ultrasonic sensor, an infrared sensor, a servomotor, and a light that is interfaced to an Arduino Uno. As a person approaches the trash can, the ultrasonic sensor measures the distance; if it is less than 30 cm, a servomotor will open the trash can lid. This ensures a better hygiene by not letting user to touch the lid.

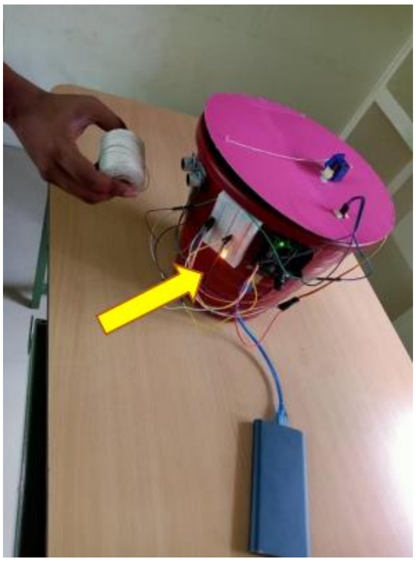

Fig 2.2- Garbage Level Detection

The fig 2.2 depicts the operation of an infrared sensor, which is used for level detection. When the bin level exceeds 80% of its maximum capacity, the led indicator illuminates and the bin remains closed, even if a human is nearby

B. *Final setup of waste segregation*

Fig 2.3 – Final setup of segregation

The waste is passed through the conveyor belt one by one in order to better identify the type of waste. As it passes through sensors, the data collected from them is used to detect the type of waste.

Table 1.1

	Inductive proximity sensor	**Moisture sensor**	**Waste bin**
Metal	✓	-	Metal waste section
Wet	-	✓	Wet waste section
Plastic/Dry	-	-	Plastic/Dry waste section

The table 1.1 shows which sensor identifies and waste bin it gets assigned to.

Images are taken during the sensor segregation process by the camera and used for identification by the image processing algorithm.

C. *Conveyor belt setup*

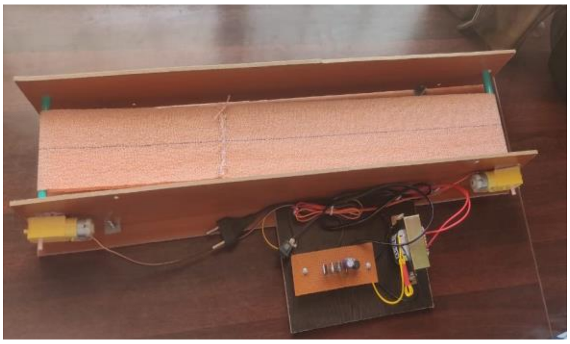

Fig 2.4 - Conveyor belt setup

The model, shown in the figure 2.4, is implemented using bridge rectifier, capacitor, 12V voltage regulator(LM7812C), 5V voltage regulator(L7805C).

Initially, the positive terminals of both motors are connected to a common point, such as the center of an H-bridge. Then connect the negative points of the first motor to the output of one L7805CV voltage regulator, and connect the second motor's negative connection to the other L7805 voltage regulator's output. The input of both voltage regulators to the output of the LM7812C voltage regulator are interlinked. A Capacitor is placed between the input of the LM7812C voltage regulator and ground to filter out any voltage spikes or noise in the input voltage.

A high voltage signal is applied to the base of a PNP transistor connected to the first motor and the base of a second PNP transistor connected to the second motor receives the same signal to turn it on and off as required. When the first PNP transistor is turned on by the high voltage signal, it provides a direct path for current to flow through the first motor, causing it to rotate in one direction. At the same time, the second PNP transistor is turned off, preventing current from flowing through the second motor. When the second PNP transistor is turned on by the same high voltage signal, it provides a direct path for current to flow through the second motor, causing it to rotate in the same direction as the first motor. At the same time, the first PNP transistor is turned off, preventing current from flowing through the first motor.

By alternating the high and low voltage signals to the bases of the two transistors, you can control the direction and speed of the two motors to make them rotate in the same direction. The LM7812C and L7805CV voltage regulators ensure that the motors receive a stable and constant voltage supply, which is important for their reliable operation.

D. Segregation setup

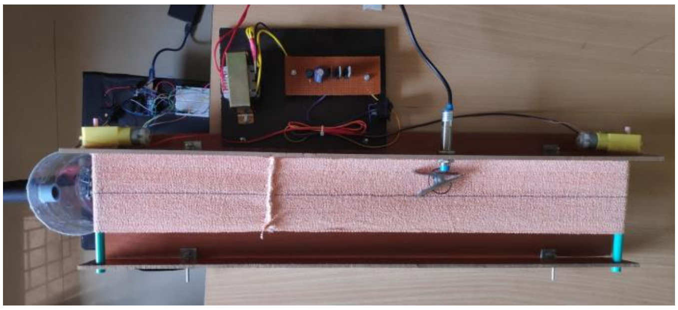

Fig 2.5 – Segregation Setup for metal waste

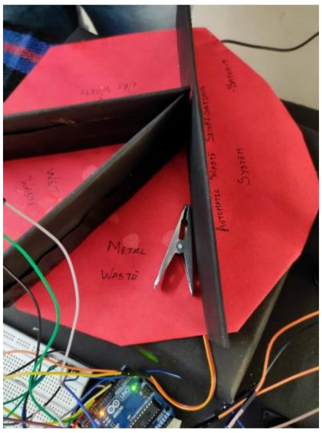

Fig 2.6 – Metal waste in Metal bin

When a piece of scrap metal is positioned on the conveyor, as shown in Figure 2.5, it moves along it. During the forward movement, it is detected by the inductive proximity sensor. This detection allows the waste bin to rotate to collect the waste in the metal waste section as shown in Figure 2.6.

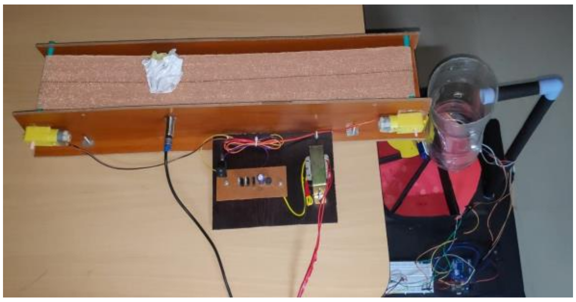

Fig 2.7 – Segregation Setup for wet waste

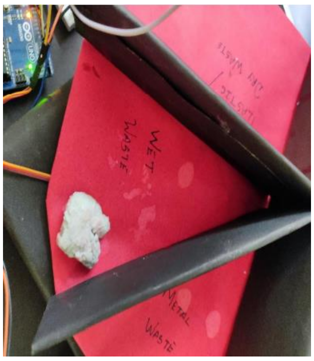

Fig 2.8 Wet waste in Wet bin

When a piece of wet waste is placed on the conveyor, as shown in Figure 2.7, it moves along it. During forward movement, it is detected by the moisture sensor. This detection allows the waste bin to rotate to collect the waste in the wet waste area as shown in Figure 2.8.

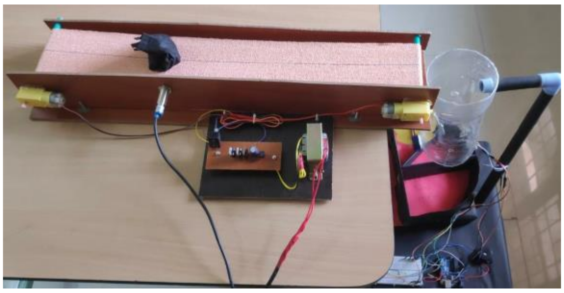

Fig 2.9 – Segregation Setup for plastic waste

Fig 2.10 – Plastic waste in Dry bin

When plastic waste is placed on the conveyor, as shown in Figure 2.9, it moves along. While moving forward, it is not detected by either sensor. This will cause the waste bin to rotate to collect the waste in the plastic waste area as shown in Figure 2.10.

E. Image processing setup

We use SSD MobileNet V3 for image processing of the waste. As the different types of waste move forward on the conveyor belt, images are captured by the camera. This is used to identify the object's name via SSD MobileNet V3. Later this will be used to categorize the type of waste. It is currently used to identify at least 80 items.

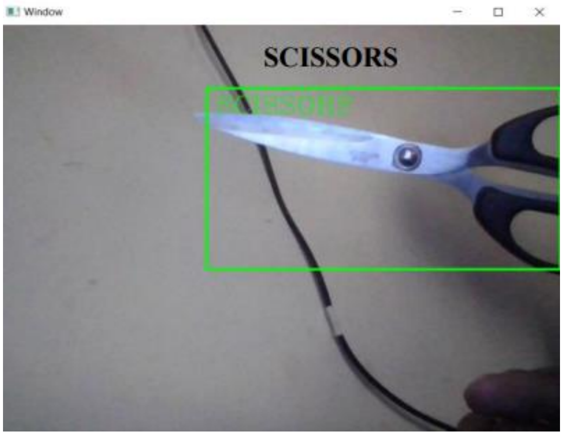

Fig 2.11 Image Processing (Detecting Scissors)

Using image processing, metal waste can be found as shown in the figure 2.11. The waste is detected as scissors and this waste is programmed as metal waste.

Fig 2.12 Image Processing (Detecting Plastic Bottle)

In the Figure 2.12, image processing is used for detecting plastic waste. The waste is recognized as scissors and this waste is programmed as plastic waste.

VI. CONCLUSION AND FUTURE SCOPE

The proposed solution for segregating waste was developed with the goal in mind to optimize and improve the current differentiated system for collection of waste. The project aims to create a better sustainable system for managing waste. Proteus software is used to simulate a smart bin and separate waste. Various Sensors, camera, and servo motor that is used to identifies type of waste and the waste is collected in the specific containers. Image processing algorithm is used to find the type of waste that is unidentified by the sensors or the mixed waste (like scissors that has both plastic and metal).

The major drawback identified is the dumping of clusters of mixed waste materials. This issue can be rectified by using a vibrator and mechanical design. Using vibrator, the cluster of waste is separated into single one and made pass through the narrow path so only one item passes at one time.

VII. REFERENCES

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