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Automatic waste segregation using robotic arm

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Abstract: This project, at the core of this endeavour lies the imperative of effectively segregating different wastes, a fundamental facet of recycling and waste management. This project introduces an ingenious approach to tackle this challenge by harnessing the power of a robotic arm. Its central mission is to conceive, fabricate, and implement a robotic system equipped with the capability to autonomously identify and segregate metal and non-metal materials. This robotic arm integrates a sophisticated suite of IR sensors, encompassing metal detectors and motors, ensuring an accurate differentiation between these two material categories. Once identified, the robotic arm seamlessly employs a precision sorting mechanism to direct these materials into separate collection bins. The integral components of this solution include IR sensors designed for precise gripping, DC motors and motor drives, metal proximity sensors, and a sophisticated microcontroller, uniting to herald a new era of waste management and resource efficiency.

Keywords: Servo motor, Power supply unit, motor driver, DC Motor, Metal sensor, Moisture sensor.

I. INTRODUCTION

Waste management is a critical aspect of maintaining environmental sustainability and public health. As populations grow and consumption increases, the proper management of waste becomes increasingly important to mitigate its negative impacts on ecosystems and human well-being. Waste management encompasses various processes, including collection, transportation, treatment, and disposal of waste materials. Efficient waste management practices aim to minimize the generation of waste, promote recycling and reuse, and ensure safe disposal of hazardous materials. It involves the implementation of strategies such as waste reduction at the source, segregation of recyclables, composting of organic waste, and the use of advanced technologies for waste treatment. Effective waste management not only helps in preserving natural resources and reducing pollution but also contributes to economic growth by creating opportunities for recycling industries and generating energy from waste. Additionally, it plays a crucial role in mitigating climate change by reducing greenhouse gas emissions associated with improper waste disposal. Conventional methods of segregating metal, wet, and e-waste typically rely on manual sorting processes, which can be time consuming, labour-intensive, and prone to errors.

Human interference in waste segregation also poses health and safety risks for workers, especially when dealing with hazardous materials present in e-waste. However, the integration of robotic arms with advanced sensor technologies offers a promising solution to overcome these challenges. Robotic arms equipped with sensors can automate the segregation process by efficiently detecting and sorting different types of waste materials based on their characteristics. For segregating metal waste, sensors can be programmed to recognize specific metallic properties, such as conductivity and magnetic susceptibility. The robotic arm can then use this information to identify and separate metal objects from the waste stream with precision and accuracy. Similarly, for wet waste, sensors capable of detecting moisture levels can be employed to differentiate between wet and dry materials. By analysing the moisture content of the waste, the robotic arm can effectively segregate organic matter, such as food scraps and garden waste, from other types of waste. Overall, the use of robotic arms with sensors for segregating metal, wet, and e-waste offers several advantages, including increased efficiency, accuracy, and safety in waste management processes. By reducing reliance on manual Labor and human interference, these automated systems contribute to the advancement of sustainable and environmentally friendly waste management practices.

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II. RELATED WORK

"AUTOMATIC SEGREGATION OF WASTE USING ROBOTIC ARM", Bhoomika P M, Sonika V, Suma B S, Vismitha S S, Mrs. Sangeetha V: This paper proposes an Automated Waste Segregator (AWS) which is a cheap, easy to use solution for a segregation system. At households so that it can be sent directly for processing. It is designed to sort the refuse into wet waste and dry waste. The AWS employs capacitive sensors to distinguish between wet and dry waste.

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Experimental results show that the segregation of waste into wet and dry waste has been successfully implemented using the AWS. This system employs an IR sensor moisture sensor and an ultrasonic sensor to perform the various operations. It consists of dc motors to drive the system. A Wi-Fi module is incorporated to get the notifications respectively when a certain action is performed. In the proposed model has two dust bins (named as Dust bin A and Dust bin B) which will be kept at public places mostly. Dustbin A can be used but Dustbin B cannot be used until Dustbin A is full. Dustbin B can only be used once Dustbin A is full and then Dustbin A will not open until the waste is cleared in the Dustbin A. Whenever any dustbin is filled up, a message is sent to the concerned authority. This will avoid the overflow of waste in the bin. Dust bins have automatically closed and open features depending on the presence of an obstacle. The proposed system consists of double dustbins, where second Dustbin B cannot be used until and unless Dustbin A is filled. Dustbin B can only be used once Dustbin A is full and then Dustbin A will not open until the waste is cleared in the dustbin A. Two IR sensors are placed in the front of the bins so that whenever any person comes in front of dustbin it opens and closes automatically using a servo motor. An ultrasonic sensor is used to measure the level of waste inside bins. Once the Dustbin A or B gets filled up a message is sent to the concerned authority via GSM module.

"AUTOMATIC SEGREGATION OF WASTE USING ROBOTIC ARM", B.S Usha, Rahul Madhukara Shanbog, Shaik Hussain, Shreyas H.K, Shreyas S, Associate: The main purpose of this project is to contribute to the society by reducing the human intervention. The overall Objective is to categorise waste materials into different partitions for the disposal consideration, to take proper measures for waste handling and to promote prevention, preparing for reuse, recycling, other recovery and disposal. It mainly focuses on various options available for the disposal of waste for a brighter and more sustainable future. The main purpose of this project is to contribute to the society by reducing the human intervention. The overall Objective is to categorise waste materials into different partitions for the disposal consideration, to take proper measures for waste handling and to promote prevention, preparing for reuse, recycling, other recovery and disposal.

It mainly focuses on various options available for the disposal of waste for a brighter and more sustainable future. In this project ROBOT is designed using DC Motors and Motor Drivers. It consists of a IR sensor to detect the waste material, a robotic arm to pick and place the waste into the conveyor, moisture sensor to detect the wet waste and inductive proximity sensor to detect metallic waste and a Ultrasonic sensor to detect the level dustbin. Dustbin has three parts i.e., one for dry waste, wet waste and metallic waste. DC motors and motor drive for the movement of robot and robotic arm. A Wi-Fi module (ESP8266) to send information and a microcontroller (ARM7 LPC2148).

"SMART ROBOTIC ARM BASED WASTE SEGREGATION SYSTEM", Dr. Sumaiya M N, Dr. Kavitha G R: Waste segregation is a simple method of reducing the amount of waste dumped into our landfills. Large amount of recycle waste in different category are not segregated properly. A solution to this is Automated Waste Sorter and robot waste deliver system are intended to automate the sorting process of wet, dry and metallic waste. In this system at first the IR sensor is used to detect the waste in front of the smart bin. Along with this we integrate a robot system to deliver the process of collecting the waste that is to be sorted by the AWS, to minimize the human interference. The robot arm system is composed of dc motors and gear drivers that is able to mechanically pick up the waste and put it at platform which consists of sensors like moisture sensor to detect dry and wet wastes, also proximity sensor to detect metallic waste and based on coding rotate the slotted bin to dump the waste based on colour coding and colours assigned for different types of wastes. Also, ultrasonic sensor placed at lid of bin detects the level of waste inside bin and sends notifications to empty it once it is full via GSM module. Experimental results show implemented using the Automated waste segregation system.

"DESIGN OF RECYCLABLE WASTE SEGREGATING ROBOTIC ARM", R. Rajalakshmi Manoj Kumar, Nithiesh, Ragulsuriya R, Sudhakar S, Nithesh A: Robotic based automation system for waste recycling requires the modes of operation such as object finding, Object categorization and movement. All the modes should be properly integrated to perform the required segregation. Improper methods of waste segregation and recycling process lead to bad environment health and thus by all means gave the motivation for the work proposed here. The first step is to identify the waste for the further process such as recyclable waste and non-recyclable waste. With a proper identification the segregation of the waste is achieved. So, the recyclable waste can be sent to the recycling industry and they are not dumped in the dump yards. There is an unavailability of garbage collectors in the society to pick and segregate wastages from our surrounding regularly. This pandemic situation makes the situation even worse in the garbage collection and segregation process. So, there is a necessity for a robotic based system to take into action. Thus, this work aims to design a robotic arm to segregate recyclable waste from the non-recyclable waste. The Recyclable waste such as plastics and metals along with other wastes are placed the conveyor belt. The conveyor belt moves along with these wastes in a constant speed of 300 RPM which is run by a DC gear motor. The DC gear motor is interfaced with the L298N motor drive. The motor driver module takes low voltage input from the microcontroller Arduino.

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The IR sensor is placed at the beginning of the conveyor belt to detect the presence of the wastage. The plastic waste is sensed by the electro static field of the capacitive proximity sensor. The Inductive proximity sensor senses the metallic waste with the help of Electromagnetic field. The sensors are interfaced as the input to the Arduino and the Robotic arm is interfaced to receive the output produced by the Arduino. The Robotic arm is placed perpendicular to the conveyor belt. The precision movement of the robotic arm is controlled by the DC servo motors one is for shoulder and another is for elbow. When the desired waste is detected such as plastic and metal waste, it is pushed into the respective dust bins. The remaining wastes are collected at the end of the conveyor with separate dust bin. The command to the Robotic arm is given by the Arduino. The coding is written by using python to execute the instructions in a proper manner. Then it is encrypted in the Arduino. Thus, the total operation is controlled by Arduino.

"WASTE SEGREGATION USING ROBOTIC ARM", U. Madhukar, M. Pavithra, S. G. Mangala Gowri: In this paper we can see that a deep learning model was utilized to estimate future garbage levels. With an accuracy of 80.33 percent, the suggested neural network model was able to forecast garbage levels. The findings support the accuracy of the rubbish level forecast. Bar charts were also used to analyses the data. The combination of IoT and deep learning can result in a technological revolution that can be used to trash management. As a result, forecasting and examining garbage levels may assist municipal authorities in implementing an efficient garbage management system and reducing rubbish bin overflow. The robotic based waste segregation is very effective to detect the waste and segregate the waste into different categories. There are many sensors used to detect the waste in the surroundings and the data is sent to the controllers, from which the robot moves accordingly. The sensors used over here are IR sensor, wet sensor, metal sensor, pi camera, motor driver, power supply etc. These above components are used for the function of the robot for segregating the waste. This method can be used for a clean environment and help to reduce pollution.

III. PROPOSED SYSTEM

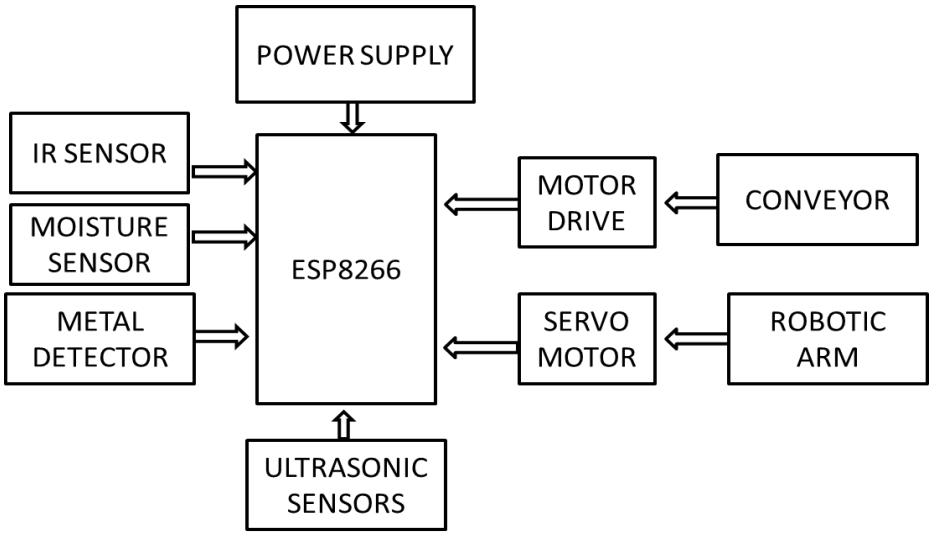

Fig 3.1: Block Diagram of Automatic waste segregation using robotic arm

In this project, an intricately designed robotic arm, outfitted with servomotors and motor drivers, takes centre stage. The purpose is to efficiently manage waste segregation through intelligent sensing mechanisms and precise manipulations. Two key sensors, the Metal sensor and moisture sensor, form the backbone of waste classification, enabling the arm to distinguish between metal waste, wet waste, and e-waste with remarkable accuracy. Picture this: as waste is introduced onto the conveyor belt, the system springs into action. For metal waste, a seamless journey awaits as it moves along the belt. Strategically placed IR sensors detect its presence, orchestrating a choreographed drop into the metal waste bin at the precise moment, ensuring swift and efficient disposal. Meanwhile, for wet waste and e-waste, a slightly different process unfolds. The moisture sensor triggers the conveyor belt into motion, guiding the waste towards the waiting arms of the robot. The robotic arm delicately picks each piece of waste, discerning its type with precision. Wet waste finds its home in the designated bin, while e-waste is gently deposited into its own receptacle. Throughout this ballet of automation, the status of each bin is vigilantly monitored. The LCD displays, acting as vigilant sentinels, dutifully report the levels within, ensuring timely intervention when bins approach When a bin reaches its limit the system is prepared.

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The robotic arm, ever vigilant, halts its operations, patiently waiting for human intervention to clear or replace the filled bins. And to conserve energy, the conveyor belt remains dormant until waste is detected, activating only when needed, a thoughtful nod to sustainability in design. Underpinning this intricate dance of technology is the software, written in C, orchestrating each movement with precision. Powered by the ESP32 microcontroller, this system embodies the combination of hardware and software, seamlessly integrating sensors and displays into a harmonious whole. With every action and reaction meticulously choreographed, waste management transcends mere functionality, becoming a symphony of efficiency and innovation. Overall, it reduces the human intervention, is much faster and precise. The figure below shows the flow chart:

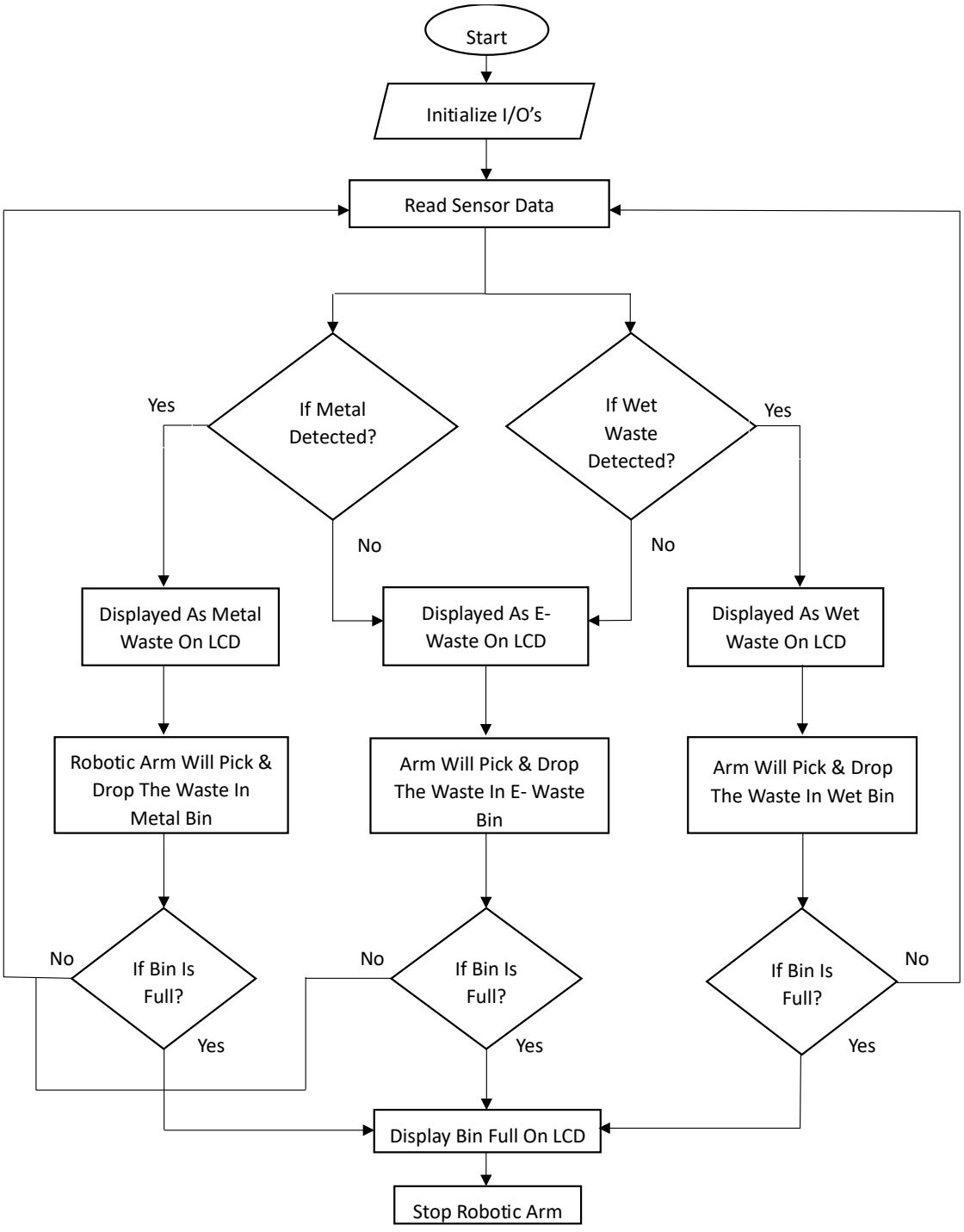

Fig 3.2: Flow Chart

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IV. EXPERIMENTAL RESULTS

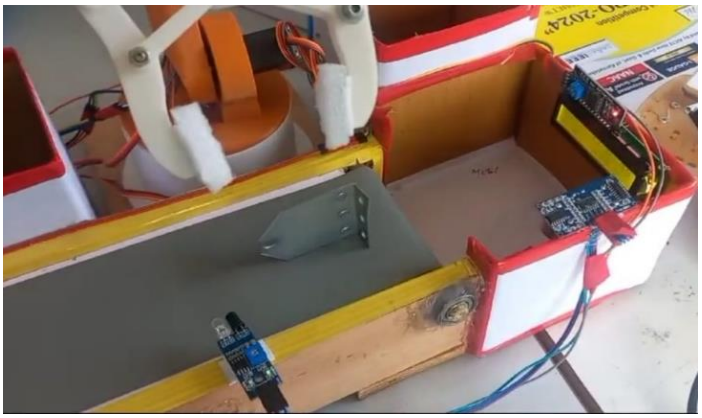

Fig 1: Metal Waste Moving to Designated Bin

In Fig 1 the waste is sensed by metal sensor then moved to the designated bin.

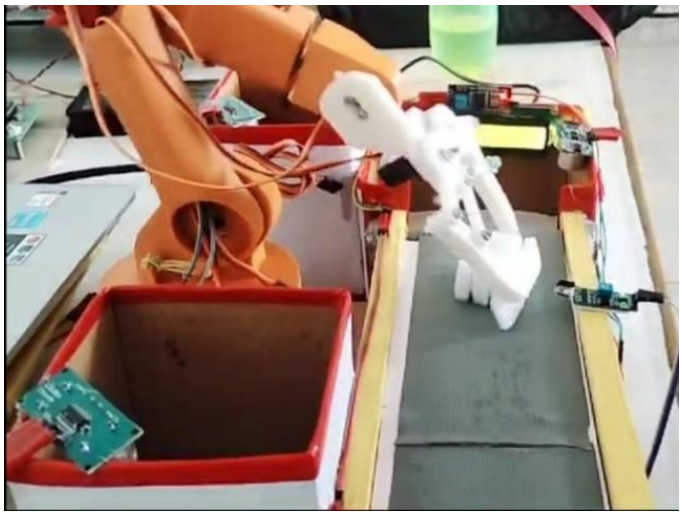

Fig 2: Arm Picking Wet Waste

In Fig 2 the waste is sensed by moisture sensor then robotic arm will pic and drop in the designated bin.

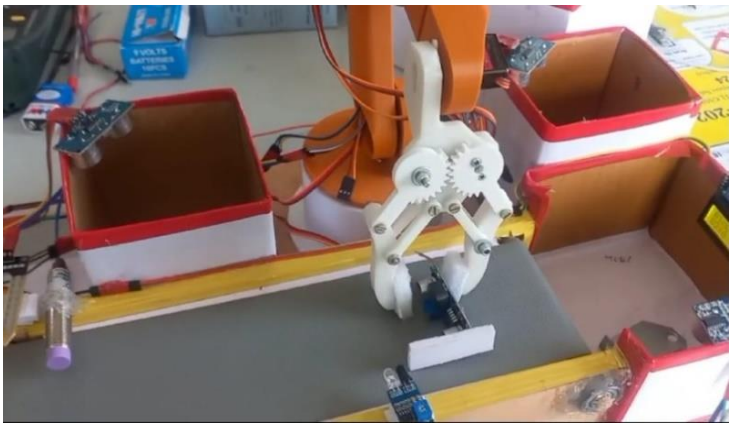

Fig 3: Arm Picking E-Waste

In Fig 4.3 the waste is classified as e-waste then robotic arm will and drop in designated bin.

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V. CONCLUSION

Automatic E-Waste Segregation using the Robotic Arm performs the segregation into metal, wet and E-waste. When the sensors are triggered, the motor-powered arm is actuated and the waste are dispensed onto its proper bins. This system is more innovative as it includes an automated system and a robotic arm, making it a more effective and efficient system. This research takes a step forward in contributing towards the cleanliness of our society. This system can be made more advanced and efficient by using a crusher and artificial intelligence in the future.

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