Section A-Research paper

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IoT-Based Waste Segregation System usingATMega and Active Sensor Data

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Abstract*— One of the most crucial consequences of population explosion in these recent years has been environmental hazards. As the number of human inhabitants does not cease growing, garbage gathered is being discarded without any segregation, as an aggregate of disintegrable and non-perishable. Individuals dump garbage along the roads and the people hailing from the corporation do not accumulate the scrap evenly. This work by us proposes an automated garbage separation bin, a project in line with the current government scheme to make our country clean and hygienic. This swift scientific development has led to cost-effectiveness. This system suggests intelligent segregation and management based on the Internet of Things that sorts wastes such as Metal, Wet, and Dry waste using sensors like ultrasonic, proximity sensors, and Servomotors, interfaced with Arduino UNO. The complete flow of sorting is monitored and controlled by programmable microcontrollers and their respective transducers for input, which in turn contributes to the reduction of exposed disposal of biological scrap and thus the advance of microbes. The incoming waste passes through a conveyor belt, where the required sensors are placed in a linear arrangement. In the end, a dustbin divided into 3 equal parts is joined to the servo motor for switching according to sensor data.

Index Terms— Waste segregation, IoT, Arduino UNO, Proximity sensor, Smart city, Sensors

I. INTRODUCTION

Abundant population growth has led to improper disposal of waste. Waste management takes more time and effort. Currently, waste disposal has come to be a large purpose. The maximum not unusual waste disposal approach is unplanned and amassed waste is recklessly dumped in landfills. This technique causes detrimental outcomes for all sensitive beings and their surroundings. A notable inflationary wave in a municipal solid waste generation was recorded. worldwide due to overpopulation, industrialization, economic growth, and landfills that cannot be recovered due to improper waste disposal in the suburbs of cities causing important environmental problems. This approach can produce sickness-susceptible viruses that contaminate surfaces and groundwater as well as accelerate harmful illnesses main to the dilapidation of the esthetical value of the environs. Prominently, in India, solid waste recycling executed by scavengers performs a critical in this technique and it does reveal the scavengers to many medical well-being issues together with skin infections, and respiration problems including scrap-choosing addiction can be reduced by means of enforcing computerized rubbish sorting aggregation, inside the trash. Waste is classified into fundamental important streams together with metals, and dry and wet waste, these wastes have the excellent capability for recycling and reuse. Although there are a few commercial waste sorters, it's miles higher to sort waste on the supply itself. The benefit of this sort of sorting is that there's no need for a rag picker to kind the garbage as a guide procedure. Rather, the sorted waste may be sent without delay to the recycling plant, rather than sending the waste to the sorting plant and then to the recycling plant, therefore maximizing efficiency. Presently, no automated rubbish sorting gadget for dry, moist, and steel waste is under regular application, the principle objective of this assignment is to lay out a compressed, cheaper, and user-friendly scrap sorting gadget for urban cities to streamline waste control procedures. This machine will be a budget-friendly project which makes use of Arduino UNO, sensors like an Ultrasonic sensor, an Inductive proximity sensor, a Soil moisture sensor, and a Servo motor as an actuator for the system. It has two wheels coupled using an elastic fabric, to be employed as a conveyor belt which is maneuvered by a DC motor using an external power supply.

II. LITERATURE REVIEW

Das et. al [21] (2021) proposed their work here they distinguish between parched and moist waste based on the change in relative humidity when damp waste is present. The proposed model was efficient and cost-effective. Additionally, the Universal Object Interaction (UOI) and 802.11 Wi-Fi standards made it possible to assess the status of waste bins via smartphones for domestic use and for commercial businesses.

Goel et. al [4] (2021) projected in their work that wet waste is being turned into compost so that it can be utilized in organic farming, urban agriculture, and horticulture. Along with these two capabilities, the waste management center is informed via an Internet of Things system if a dry or metallic rubbish bin is full, helping to avert overflowing landfills that pose grave environmental risks so as to maintain hygiene and cleanliness in public spaces in order to correct all the anomalies.

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C. Srinilta, S. Kanharattanachai [18] (2019) This study inspected how more than nine thousand photographs of municipal solid junk were classified into different categories using CNN-based waste-type classifiers. You can determine the waste type instantly from the rubbish-type allocator or indirectly from the garbage-item category. In the experiment, developed using previous classifier models achieved better results than their corresponding fundamental models. The generated model had a top type of waste classification accuracy of more than ninety percent.

Rao et. al [11] (2020) designed a dustbin, which is constructed using a prototype and activates automatically when it detects surrounding waste. Dustbins are circulated throughout the city and given a low-cost embedded technique to aid in rubbish bin tracking. When the garbage reaches its maximum level, the IoT cloud platform alerts through notification to the unwanted management department, which will further take immediate action.

Fadhullah et. al [1] (2022) in their work gathered some data using a cross-sectional survey opinion poll and a graded random sampling method. They performed a survey that involved the cross-examining of more than three-hundred houses in total, and the SPSS model was employed in order to analyze the data. The links between categorical variables were estimated using the Chi-square goodness of fit test, whereas the Chi-square bivariate correlation test was exploited to look at the connection between the respondents' impressions of waste management and their anthropometric background. Their findings stated that almost fifty percent of people do not segregate waste and more than ninety percent of people were aware of diseases it could cause.

K. Jaishankar et. al [12] (2020) proposed a design that made use of Message Queuing Telemetry Transport (MQTT) for waste segregation and monitoring where a cohesive network for waste exclusion and surveillance has been offered as the solution to this issue. The embedded system will record the amount of waste dumped. In the segregation portion, garbage is separated into damp scrap and moist scrap, and in the surveillance portion, the bins containing dehydrated waste and moist waste are implanted with sensors.

H. Joshi, Amit Mittal [5] (2020) presents a novel approach to waste management by integrating the Internet of Things (IoT) technology into the process of waste segregation. The paper presents a detailed description of the proposed system architecture, which includes particularly soil moisture sensors, microcontroller namely ATMega168, and a cloud-based database. Finally, the authors evaluate the performance of the proposed system through percentage-wise moisture threshold values and conclude that the integration of IoT technology can significantly improve the efficiency and effectiveness of waste segregation. Thereby, the paper provides an in-depth comprehensive review of the state of the art in waste management and proposes a promising solution to the challenges faced by traditional waste management systems.

III. METHODOLOGY

A. Tools and Technology used

1. ATMega: ATMega is employed using Arduino, a non-proprietary processing that can be automated, deleted, and reorganized with no trouble at any time. Introduced in 2005, the Arduino platform was designed to provide low-cost and all-user-oriented individuals to create. [1] In our system, we are using the Arduino microcontroller board to operate the inductive proximity detector, ultrasonic detector, and soil moisture detector as our input devices and the servo motor as an actuator.

Fig 1.1 Arduino UNO R3 microcontroller

2. Inductive proximity sensor: It holds its application in our proposed system since it detects ferrous and non-ferrous metallic objects. It detects the magnetic eddy current loss on the surface of the target body along an external magnetic field.[2] It is used as a digital sensor to decide whether the waste received will fall under the metallic category or not.

Fig 1.2 Inductive proximity sensor

3. Soil moisture sensor: The soil moisture sensor is used to measure the moisture level in soil or any wet

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object. This sensor mainly uses a condenser to measure the dampness of the soil (based on diffusivity). The operation of this sensor can be performed by plugging this device deep into the soil and the soil water content standing can be reported in the form of a percentage.[3] It gives output as a value that is passed through a condition where its extent of dampness is estimated. It detects incoming wet waste and after its encounter, it is separated.

Fig 1.3 Soil moisture sensor (with module)

4. Ultrasonic sensor: It is a digital sensor that gives data through PWM pins when interfaced with Arduino UNO. It is applied to sense plastic or any other dry waste, entering the conveyor belt.

Fig 1.4 Ultrasonic sensor

5. Servo Motor: Servo motor is a kind of motor that could switch with excessive meticulousness. Typically, this form of rotatory device accommodates a regulation of the shape of circuitry that offers a reaction about the modern place of the tool shaft, which permits the servomotor to rotate with high precision. In case you need to rotate an object at unique angles or distances, you operate servo automobiles. The servo motor axle will be connected to a dustbin divided into 3 equal parts namely 'Wet', 'Dry', and 'Metal'. As per the nature of garbage entering the system, the sensors will send data to the microcontroller board and the servo motor will rotate as per the respective bins.

Fig 1.5 Servo motor

6. DC motor: A simple DC motor is used to drive the wheel coupled with another wheel using elastic fiber thus constituting the conveyor belt arrangement. The DC motor will be linked with IRF Z44 and Potentiometer giving the user the liberty to change the speed as per requirement.

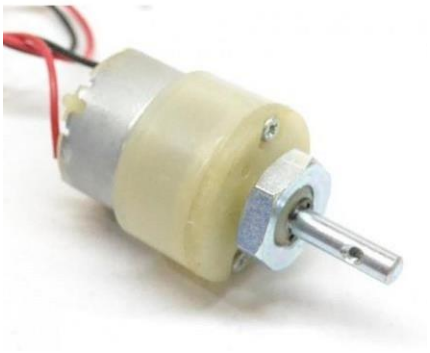

Fig 1.6(a) A Simple DC motor

Fig 1.6(b) IRF Z44 Mosfet

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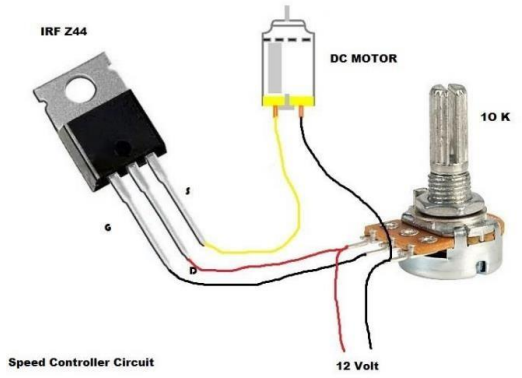

Fig 1.6(c) Representation of the motor driving section of the circuit

B. Flowchart of the proposed system

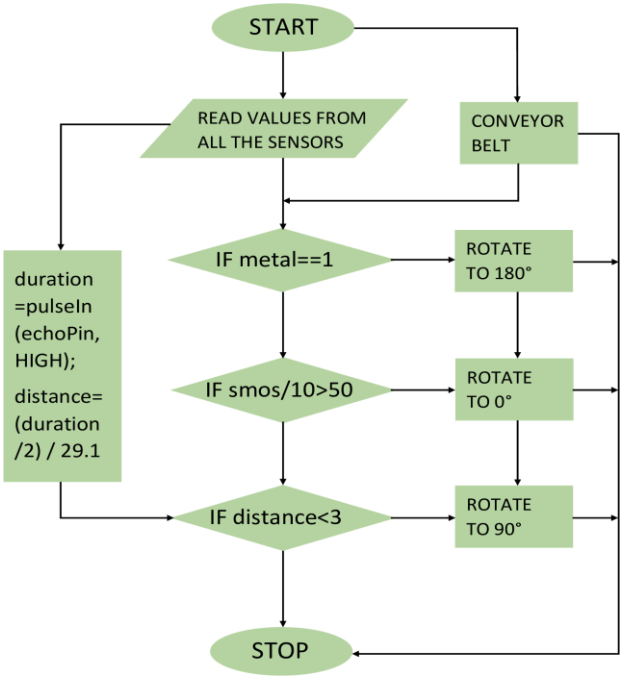

Fig 1.7 Flowchart of code made in Arduino IDE

C. Architecture of the proposed system

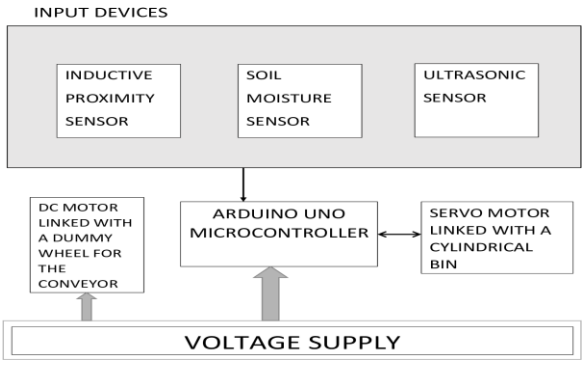

Fig 1.8 Architecture diagram of the proposed system.

The 'Input devices' block describes the sensors linked to the microcontroller board from which data in the form of electric signals are transmitted to the microcontroller board, which subsequently performs all the necessary operations as per the coding implemented according to the flowchart. The Inductive Proximity Sensor is an active sensor that requires 9V for its operation. Its signal pin is linked to the microcontroller and the positive terminal is connected to a 9V external battery. Other sensors involved in the circuit have an operating voltage of about 3.3 to 5V. Therefore, their positive terminals are connected to the microcontroller. All the negative terminals of the sensors and actuators are connected to the common ground established by using the breadboard. The actuator used in this hardware system is the servo motor. The servo motor holds a cylindrical bin, made up of cardboard and partitioned into three equal sections, namely: WET, DRY, and METAL. A conveyor belt arrangement exists in parallel to the complete sensor-microcontroller-actuator circuit. The conveyor belt has two wheels: one wheel is a dummy wheel with its dummy axle, and another wheel is coupled with a DC motor. The DC motor has an independent circuit where it is linked with IRF Z44 MOSFET used as a voltage regulator, a potentiometer, and a DC Power Supply of 9V. An elastic belt is used to couple both wheels to convert rotatory motion to translatory motion of the waste particles' incident on the conveyor belt. This motion is speed-controlled using the Potentiometer.

IV. RESULTS AND DISCUSSIONS

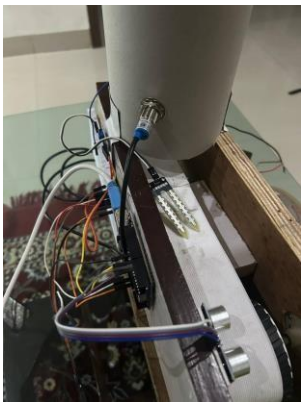

Fig 1.9(a) The complete system

This project improves the cleanliness of smart cities through the practical application of sorting and automatic waste management system using IoT. With urbanization and exponential growth in the number of inhabitants, garbage discarding is a foremost apprehension. This proposed machine is a good waste sorting machine without any human intervention or challenge to isolate the dry and wet waste. It ensures timely collection and disposal. The proposed machine will be deployed on a home scale in families or on a massive scale in public locations like housing societies, workplaces, factories, and so forth. This system can be implemented in our daily life, where will be able to separate dry and wet waste with ease.

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Fig 1.9(b) The top view of complete system

V. FUTURE SCOPE

The current system is running smoothly, however in order to segregate garbage accumulated in chunks, could become time-consuming but could be improved through the filtration process, followed by segregation. It can also be extended to CNN algorithms and machine learning which would make this system more robust. The entire circuit could be assembled in a more compact PCB, thus reducing the common wire complexities and it could have solar panels as a power source during day time.

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