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REVOLUTIONIZING WASTE MANAGEMENT USING IOT-DRIVEN AUTOMATED SEGREGATION

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Abstract- **With the increase in development of smart cities, the idea of keeping the cities clean is the utmost requirement. The amount of garbage produced is too large and the manual efforts required to process it is very tedious. With evolution of technology in every field, automated ways can be adopted to prevent the piling of the garbage. The waste segregator is designed to provide ease in the disposal of waste that is collected. The system consists of three bins, each one for wet, metal, and dry waste. The conveyer belt system detects the incoming waste and classifies it as metal, dry or wet using different sensors connected to the system and deflects it in the respective bin. The deflection procedure is carried out by the servo motors which are programmed according to the working. This facilitates in processing the different kinds of waste as per the requirement. The garbage level in each of bins is monitored using the ultrasonic sensors present in every bin. The notification is then sent to the concerned authorities for emptying the bin. The whole setup brings about automation and hence reduces the human intervention required in segregating the waste and provides successful collection of the garbage from the bin at the appropriate time. The system is driven by a microcontroller- Arduino UNO, and the sensors are programmed using the language- Embedded C.**

Keywords- **Dry, wet, metal, sensors, Arduino UNO, Embedded C**

I. INTRODUCTION

With the increase in population year after year, the amount of waste generated is increasing tremendously. This has led to many hazardous problems. The accumulation of the waste in large areas of land results in the formation of landfills which have dangerous consequences. The odour of the rotten waste pollutes the surrounding environment by releasing a foul smell. The disposal of the waste in water bodies contaminates all the linking oceans and seas which affect the quality of drinking water and also the lives of the water animals. The toxic gases are released into the air and in turn the whole ecosystem is affected. Therefore waste management is a very serious issue in today's era. If the waste produced is effectively handled at the source level, a lot of things can be changed and prevented.

The segregation of waste into wet, dry and metallic categories can help in discarding the waste appropriately and in implementing the principle of Reuse, Reduce and Recycle. The wet waste can be decomposed to produce manure for the plants, the metallic waste and the dry waste can be recycled. Thus the Automatic Waste Segregator has

a lot of applications in the management of the waste. The system separates the waste in 3 different bins under the category of wet, dry and metallic. Different sensors are used for the detection of the type of waste. The level of the garbage in the bins is monitored continuously so that the bins don't overflow and they are emptied timely. The notification is sent to the concerned authority with the location at which the bin is placed.

II. RELATED WORKS

Waste Segregation using Deep Learning Algorithm

This paper presents automatic waste classification based on Convolution Neural Network. It separates the waste into non-biodegradable and biodegradable categories using Deep learning based image classification. The concept of Deep Learning permits "processing of numerous layers through the computational models in order to learn data representations with abstraction of multiple layers." This is appropriate for huge measure of waste. Classification of the materials in real time is done by using webcam with python index package. Tensor flow and Spyder are the open source software libraries that are used. The training process is very time consuming. It prevents manual work to a large extent. The system reduces pollution level to a large extend and has a possibility of becoming a large framework in the coming years. [1]

Waste Management using Internet of Things (IoT)

This paper studies the amount of time and money that is wasted due to the scheduled visits to the dustbins in the area. There are times when the workers find the bins to be overflowing and other times when the bins are not even filled to the brim. This causes one of the main reasons for inefficiency in proper collection of waste and is also harmful for the environment. Hence a smart bin which is solar powered and compacts the waste is developed. It has sensors present in it which screen show much waste has been amassed and consequently makes the waste compact so that it holds up to 10 times of the ordinary containers. It can remotely transmit the fill level utilizing cloud server. The bin can be utilized as a Wi-Fi hotspot and is powered by either battery or solar energy. It detects how much waste is inside the compartment and remotely transmits fill level data to cloud server. This results in productive utilization of time and keeps the roads more hygienic. [2]

IOT Based Smart Garbage Monitoring and Alert System Using Arduino UNO

It builds up a system for disposal of garbage by notifying an alarm to the web server of the municipal corporation. It notifies the moment of cleaning the waste in the bin by keeping legitimate check on level of trash filled. The ultrasonic sensor connected to the Arduino UNO is used to measure the trash collected in the container. The entire procedure is maintained by incorporating and utilizing GSM and GPS based on Internet of Things. An Android application is created and it has constant connection to the municipal web server to upload the alert received from the Arduino and ensures remote observing.[3]

Standalone Frequency Based Automated Trash Bin and Segregator of Plastic Bottles and Tin Cans

The paper shows how the piezoelectric amplifier framework can be utilized for input signal procurement and noise can be eliminated using a comparator. The average frequency response of the object triggers the framework as it hits the platform. The Arduino decides the further processing steps. Galvanized iron is used for the fabrication of the platform and it is associated with a DC engine that isolates the items. There is an overlapping in the frequencies of the metal jars and plastic found with middle values of frequencies in spite of the fact that there were barely any examples which cause the overlapping. When the bottom of the plastic container hit the platform first, results demonstrated the framework's precision when the top hit the stage initially was higher contrasted with the bottom value.[4]

Eco-Friendly IOT Based Waste Segregation and Management

The viable and effective techniques for assortment and isolation of waste at residential level dependent on the nature of composition are concentrated in this paper. The waste is put away as it needs to be in their particular portions of the dustbin as metal, plastic and biodegradable. The biodegradable waste is distinguished by the discharge of methane gas and after a particular amount of gas, liquid is sprayed on it. The fill status of the dustbin is observed and data is sent utilizing Wifi module. At the point when a certain level is reached, notification is sent to the client to advise that the specific portion is covered and it must be discarded. The whole setup of the bin is driven by STM32 microcontroller. Likewise the plastic just as metal waste are recognized and isolated into their separate areas utilizing capacitive and inductive sensors respectively.[5] **Automated Waste Segregator**

The paper depicts a simple to utilize and a cheap way for segregation by introducing an Automated Waste Segregator. It is segregates the waste into wet waste, dry waste and metal waste. It utilizes capacitive sensors to perceive wet and dry waste and parallel resonant impedance identifying component to perceive metallic things. With an ordered priority of segregating the wet, dry and metal waste, only a single type of waste can be isolated at once. Blended kind of waste is isolated by upgrades which utilize the buffer spaces. The detection of metal waste is comparatively less, and the whole module can be

put in a solitary stage where the entity is steady to ensure better results.[6]

A Novel Approach For Waste Segregation At Source Level For Effective Generation Of Electricity – Green Bin

The paper portrays the innovation of automating the isolation of dry waste into plastics, metal, paper and glass at accessible commercial level. The isolation of the waste is determined and influenced when the waste products get contaminated. The Green Bin is intended for mechanized waste isolation at local level itself. It comprises of inductive metal sensor, capacitive moisture sensor, odour sensor and methane sensor. Capacitive based moisture sensor is utilized to decide the moisture level present in the waste. The inductive based metal sensor is utilized to detect metal content in the waste. The affirmation of food waste is determined by methane sensor.[7]

III. METHODOLOGY

The Automatic Waste Segregator System is driven by the Microcontroller Arduino UNO. All the components that are connected to Arduino UNO are programmed using the Arduino IDE. The program is written in Embedded C language and it reads the input/output pins of the components. The conveyor belt system moves when it senses the garbage. The servo motors are present to deflect the wet, dry and metallic waste into the specific bins. The metallic waste is detected by Inductive Proximity sensors. The dry waste has paper and plastic which are differentiated using the Capacitive Proximity sensor. The wet waste is examined with the help of Moisture sensor. The measure of the dustbin level is calculated by the Ultrasonic sensor connected at the edge of the dustbin. When the dustbin is full, a message- "BIN IS FULL" is sent to the cleaning authorities. The message is sent using the GSM module that provides the communication between the bin and the authority. The location of the bin can also be sent. The location is known with the usage of GPS module that is connected to the system. The fig.1 shows the stepwise working of the whole system.
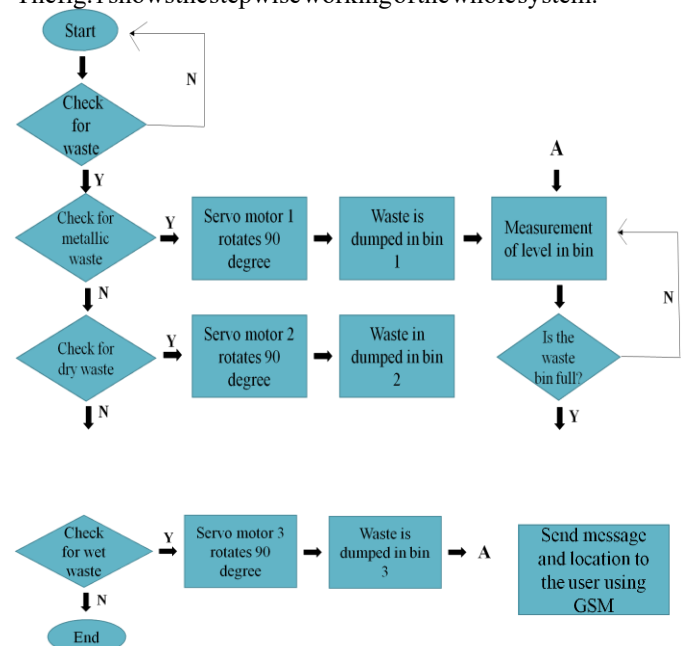

Fig.1. Flow diagram of the model

IV. HARDWARE REQUIREMENTS

ARDUINO UNO- It is an "open-source electronics platform" dependent on simple to interface hardware and execute programming. The assortment of chip and controllers is done with the help of Arduino board structures. The Arduino boards are equipped with 14 digital pins for input or output, and 6 analog pins for input that are used to interface different circuits. The customization of microcontrollers is done by utilizing Embedded C and C++ programming codes. Arduino microcontroller gives an Integrated Development Environment (IDE) that supports different programming languages. Current Arduino boards are programmed by means of Universal Serial Bus (USB).

1. FOR SEGREGATION:

CONVEYOR BELT- The belt is the moving object of the system. The system is a combination of at least two pulleys that ensure circular movement of the belt which pivots about them. The belt and the object placed on it move forward as the pulleys are powered. The pulley which is powered is the driver pulley and the unpowered pulley is the idler pulley.

DC MOTOR- It is utilized to drive the conveyor belt. It is interfaced with the Arduino UNO by means of L298 bridge IC. The direct current energy is converted into mechanical energy with the help of the rotational motor. A variable supply voltage is used to control the speed of the engine. The speed is also affected by changing the quality of current in the field windings.

SERVO MOTOR- It is used to deflect the waste to the respective bins. A servomotor is defined by "a rotary actuator or linear actuator that takes into account exact control of angular or linear position, velocity and acceleration." A suitable motor is coupled to a sensor for obtaining position feedback. The digital or analog input control signal represents the position directed for the output shaft.

MOISTURE SENSOR- It is used to identify if the garbage is wet or dry. The content of moisture in the waste is tested and accordingly it is dropped in the appropriate dustbin.

PROXIMITY SENSOR- The presence of objects is detected without any physical contact with the help of proximity sensor. It detects objects by "emitting electromagnetic field or electromagnetic radiation and observes the changes in the field or return signal." The Inductive proximity sensor is used to identify the metallic waste. For the identification of paper and plastic Capacitive Proximity sensor is used. It also differentiates between them as paper and plastic have different permittivity value.

2. FOR DETECTION OF WASTE LEVEL:

ULTRASONIC SENSOR- It is used to keep check on the garbage level of the bin. The acoustic Ultrasonic sensor is divided into three categories: receivers, transceivers and transmitters. The transmitters radiate the ultrasound by

converting electrical signals into ultrasound. It is then reflected by the obstacle and received by the receiver that converts the ultrasound into electrical signal. The reflected signals are used to interpret the position of the garbage in the bin.

GSM MODULE- Mobile telephone technology is used in GSM to provide a data link to a remote network. It is like a sim that is connected to the Arduino along with various types of data obtained from the board. The board has pins to take out +5V or other values of power and ground connections. TTL-level serial interface with the host is implemented in this technology.

GPS MODULE- It is a routing device that is connected with the Arduino UNO that uses the Global Positioning System (GPS) to determine the location of the bin. The recorded location is sent to the authorities using the GSM module embedded in the unit.
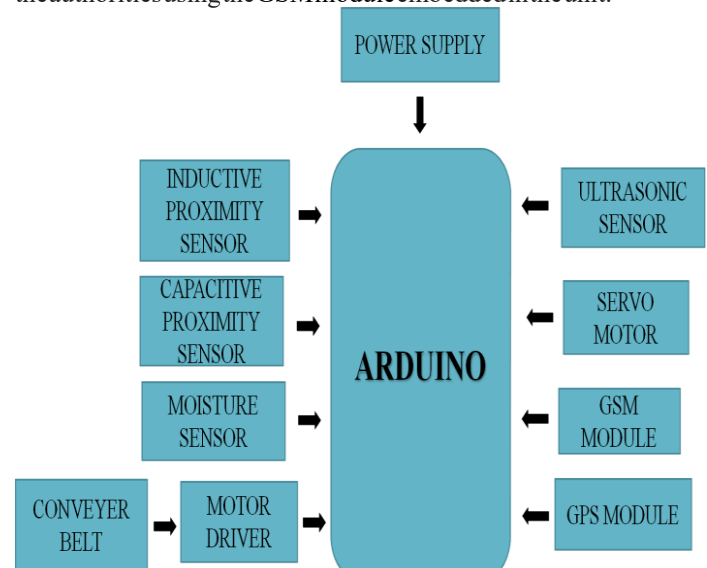

Fig.2. Block diagram of the proposed system

V. SOFTWARE REQUIREMENTS

ARDUINO IDE- A cross platform application comprising functions that are coded in Embedded C and C++. The programs are written and uploaded to Arduino boards using the IDE. In this system, the program is written in Embedded C for the working of the hardware components. The program consisted of separate methods for the detection of metallic, dry and wet waste. One method was written for sending the message to the authorities along with the location of the bin. The location of the bin was determined by another method that programmed the GPS module. The program code written on Arduino IDE was then fed to the Arduino for the working of the whole system.

VI. CONCLUSION

With the second largest population in the world, India is a developing country which has large amount of waste produced everyday. There is production of 62 million tons of municipal solid waste (MSW) each year in Urban India. 70% of which is collected and 20% get streated. Because of

the nature of different types of waste it is very difficult to discard the waste. Segregation plays a very important role by reducing the waste by reusing. Treating the waste also becomes easier if segregation is done at the base level. The fig. 3 shows the increase in the waste generated from the year 2016, to 2030 till 2050 across various parts of the world.
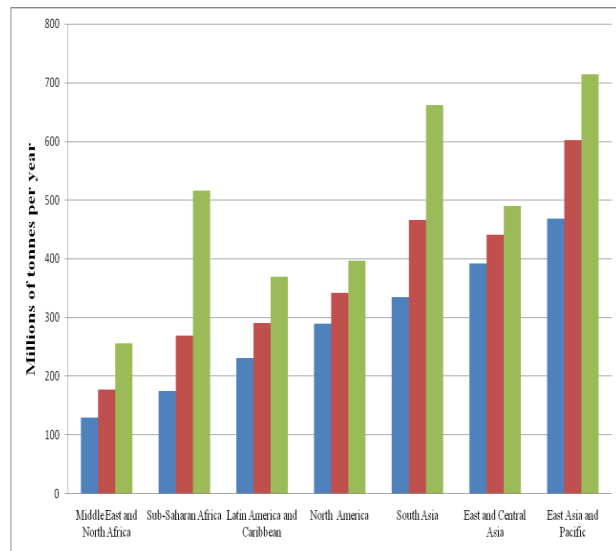

Fig. 3. Estimated increase in waste production across the world till the year 2050. The blue data represents the year 2016, red represents 2030, and green represents 2050.

Hence this indicates the increase in requirement for efficient processing of the waste to maintain ecological balance. The model developed in this paper is efficient and durable since it requires less power for its operation and no human supervision. The model can also detect when the bin is full asking the authorities to come and collect. This efficiently reduces man power, wastage of time and fuel required by the collecting van. This model fits perfectly as a replacementt to older bins and works well with the idea of smart city. With the future scope the bins can be made solar powered with better segregation techniques like digital image processing and the waste collected in the bins can be made compact to increase the storage capacity.

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