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AI-IOT BASED WASTE MANAGEMENT SYSTEM

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Abstract: The rising concern over improper waste management has motivated the need for intelligent solutions to segregate waste effectively. This project presents an AI-IoT-Based Waste Management System that automates the process of waste classification, disposal, and monitoring. By using a deep learning-based AI system for classifying waste and integrating IoT to monitor bin levels, this solution promotes sustainability and reduces human intervention. The classified waste is sorted into designated bins using servo motors, while ultrasonic sensors monitor the bins' fill levels, transmitting data to a mobile app via the Thing Speak platform.

1. INTRODUCTION

Waste management is a significant challenge worldwide, with improper segregation being a major bottleneck in recycling processes. Manual sorting is often inefficient, time-consuming, and prone to errors. Advanced technologies like AI and IoT can provide intelligent and automated solutions for waste segregation and monitoring. This project aims to integrate AI-based waste classification with IoT-enabled monitoring to create a sustainable waste management system

Today big cities around the world are facing a common problem, managing the city waste effectively without making city unclean. Today's waste management systems involve a large number of employees being appointed to attend a certain number of dumpsters this is done every day periodically. This leads to a very inefficient and unclean system in which some dumpsters will be overflowing some dumpsters might not be even half full. This is caused by variation in population density in the city or some other random factor this makes it impossible to determine which part needs immediate attention. Here a waste management system is introduced in which each dumpster is embedded in a monitoring system which will notify the corresponding personal if the dumpster is full. In this system, it is also possible to separate wet and dry waste into two separate containers.

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This system provides an effective solution to waste management problem.

Waste disposal may be a huge cause for concern within the present world. The disposal method of a large amount of generated waste has created an adverse effect on the environment. The open dumping at landfill sites may be a common method of disposal of waste. Human health, plant and animal life are affected thanks to this method. The harmful method of waste disposal contaminates surface and groundwater. It can produce to disease vectors which spread harmful diseases. This also degrades the aesthetic value of natural environment can degrade the aesthetic value of the natural environment and it's an unavailing use of natural resource. In India, rag pickers play a crucial role within the recycling of urban solid waste. Rag pickers and conservancy staff have higher morbidity thanks to infections of the skin, respiratory, alimentary canal and multisystem allergic disorders, additionally to a high prevalence of bites of rodents, dogs and other vermin. Dependency on the rag-pickers is often diminished if segregation takes place at the source of municipal waste generation. The value of the waste generated isn't realized unless it's recycled completely. Several advancements in technology have also allowed the refuse to be processed into useful entities like Waste to Energy, where the waste are often wont to generate synthetic gas (syngas) made from carbon monoxide gas and hydrogen. The gas is then burnt to supply electricity and steam; Waste to Fuel, where the waste are often utilized to get bio-fuels. When the waste is divided into wet, dry and metallic, it provides a higher potential of recovery and consequently recycled and reused. The wet waste fraction is usually converted either into compost or methane-gas or both. Compost can replace demand for chemical fertilizers, and biogas is often used as a source of energy. The metallic waste might be reused or recycled. Although there are large-scale industrial waste segregators present, it's always far better to segregate the waste at the source itself. The advantages of doing so are that a better quality of the fabric is retained for recycling which suggests that more value might be recovered from the waste. The hazard for waste workers is reduced. Also, the segregated waste might be directly sent to the recycling and processing plant rather than sending it to the segregation plant than to the plant.

2. LITERATURE SURVEY

A Smart Handling of Bio-Medical Waste and its Segregation with Intelligant Machine

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Learning Model by B. Gupta, P. Sreelatha, M. Shanmathi, J. Philip Bhimavarapu, P. John Augustine and K. Sathyarajasekara

In hospitals, medical waste disposal is arranged daily through Bio Medical waste management system. Through it, medical waste is received daily from hospitals. In particular, there is a system of separate handling of medical equipment such as needles, plastic and glassware, medical cloths, expired pills and human body waste. Based on that, they receive the medical waste daily from their respective hospitals through the Biomedical Waste Management Center and dispose it properly. Medical waste should not be dumped in any hospital. It is an offense under the law and it is the duty of the respective hospital to properly segregate the medical waste and hand it over to the biomedical waste management center. In this paper, an intelligent machine learning model was proposed to handling the different bio medical wastages and segregate it based on the medical rules. Medical waste disposed of in hospitals is safely transported and incinerated. The proposed model helpful the disposal of such medical waste, which is usually contagious, takes place.

An IoT Integrated Sensor Technologies for the Enhancement of Hospital Waste Segregation and Management by D. Selvakarthi, D. Sivabalaselvamani, M. A. Wafiq, G.Aruna and M. Gokulnath

The amount of waste has been increasing due to the increase in human population and urbanization. In cities, the overflowed bin creates an unhygienic environment. Thus degrades the

environment, to overcome this situation “Automatic Waste Segregator” is developed to reduce to

work for the ragpickers the wastes are segregated by the human beings which leads to health problems to the workers. The proposed system separates the waste into three categories namely wet, dry and metallic waste. This developed system is not only cost efficient also makes the waste management productive one. Each of the wastes are detected by the respective sensors and gets segregated inside the bins which is assigned to them the details of amount of waste disposal is updated in the server regularly.

An Intelligent Internet of Things (IoT) based Automatic Dry and Wet Medical Waste Segregation and Management System, by K. Belsare and M. Singh

Currently, with the pandemic wave, the collecting of medical waste is becoming a problem. Unwanted rubbish dumping on the edges of cities and towns causes damage,

and these overflowing landfills are impossible to restore. Moreover, the manual labour required by the current technology may result in the individual using it developing a chronic illness. The suggested system's noble goals include creating an automated system to save the lives of countless people and create a cleaner, greener society. The main goal of this paper is an intelligent Internet of Things (IoT) based dry and wet waste separation and management process of medical waste material. It detects wastes in dustbins with the aid of using sensor devices. As soon as it is detected, its waste substances will be separated with sensors. Right away, information is transferred to cloud databases via IoT, making it easier to efficiently and shrewdly remove trash from the trash can. The proposed approach will prevent harmful wastes from taking numerous lives.

Environmental Monitoring and Smart Garbage Sorting System Based on LoRa Wireless Transmission Technology by C. -Y. Chung, I. -T. Peng and J. -C. Yeh

Since the industrial revolution, scientific and technological advancements have made life more convenient and have facilitated the rapid growth of the global population. However, the amount of waste produced has also increased. Governments have invested a considerable amount of resources in solving this problem on waste source reduction and recycling. Accordingly, this study with a smart city concept developed a recyclable garbage sorting system that could be used in various locations to help eliminate littering in the city (from inconsistent waste disposal), diminish labor costs, and achieve the goals of increased recycling and reduced waste. This study integrated LoRaWAN communication networks (networks developed using the Internet of Things) with garbage sorting equipment to create a system that offers automated garbage can operation, environmental monitoring, and graphical interface monitoring. The system uses electrostatic capacitance-type proximity sensors to determine the types of garbage deposited in garbage cans. Furthermore, it contains an embedded motor and smart devices that can perform functions such as automatically opening and closing insertion points, sorting waste materials, initiating automated garbage compression, monitoring water levels, and issuing warnings when the water level exceeds the specified limit. This system employs a C# graphical monitoring interface to remind users to remove the garbage.

IoT based biomedical waste classification, quantification and management by P. Raundale, S. Gadagi and C. Acharya

Biomedical waste management and treatment is one of the critical process for organizations (HCF and CBMWTF) because if not handled properly would lead to hazardous effects like mass infection. Bio-Medical Waste (Management and Handling) Rules, 1998 was published vide notification number S. O. 630 (E) dated the 20th July, 1998, by the Government of India.[4]. 60 per cent of secondary care and 54 per cent of tertiary care health facilities were in the RED category i.e. absence of a credible BMW management system in place or ones requiring major improvement. [5] Amount of Biomedical waste generated every year is more than 8% as compared to previous per year. [6] Efforts are being taken to automate waste management by introducing wireless systems. Segregation plans are proposed in order to maximize the recycling of waste and proper handling of non-recyclable waste. That classification would not sustain in wide variety of wastes such as biomedical waste. Hence this type of waste is treated differently. Therefore, such a waste has its own management unit. This study goes over current followed practices that are undertaken by countries and also studies various available technologies to automate such processes and carefully handling biohazardous waste automatically.

3. EXISTING SYSTEM

Waste production has risen sharply in tandem with the growth of the global population. According to a recent World Bank report, cities are centers of garbage production, and the amount of garbage they produce is growing faster than their populations. This quickly becomes an environmental and economic catastrophe for cities in many developing countries. Globally, this poses serious problems for people's health. Proper waste management in urban and rural areas is crucial to maintaining a clean and healthy living environment. In an unclean and polluted environment, bacteria and viruses are primarily responsible for the spread of infections.

Which detects and segregates the waste as dry, wet, and metallic waste at the household level and also aids in real-time monitoring of garbage level in dustbins is proposed. The system detects the arrival of debris using an ultrasonic sensor and after that checks for any metal content in the waste by using the metallic sensor. Furthermore, the trash is separated as the dry and the wet residue with the use of the capacitive detector. Once the

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trash is detected and separated, the wipers help to move the trash over the respective bins, and then the platform flips. Additionally, the system displays the garbage level of the dustbins on the LCD screen. The micro controller also controls the robotic arm mechanism. The bin moves with the help of DC motor when the obstacle is detected by using IR sensor which also helps in detecting the path. Micro-controller will help in moving the robot to the place where waste is sensed using IR.

Manual systems in which employees clear the dumpsters periodically.

No systematic approach towards clearing the dumpsters.

Unclear about the status of a particular location

Employees are unaware of the need for a particular location

Very less effective in cleaning city

Traditional waste management systems rely heavily on manual segregation, which is labor-intensive and inefficient. These systems often fail to ensure proper recycling due to incorrect sorting, leading to environmental pollution and resource wastage. Additionally, the lack of real-time monitoring results in overflowing bins, causing hygiene issues and increasing operational costs

4. PROPOSED SYSTEM

The proposed system integrates AI for waste classification and IoT for bin level monitoring and alerts. A camera captures images of waste, and a deep learning model running on a laptop classifies it as recyclable or non-recyclable. Based on the classification, a signal is sent to the Arduino, which controls servo motors to sort the waste into appropriate bins. Ultrasonic sensors monitor bin levels, and the data is transmitted to the ThingSpeak platform, which updates a mobile app. Alerts are triggered when bins are near capacity, ensuring timely disposal

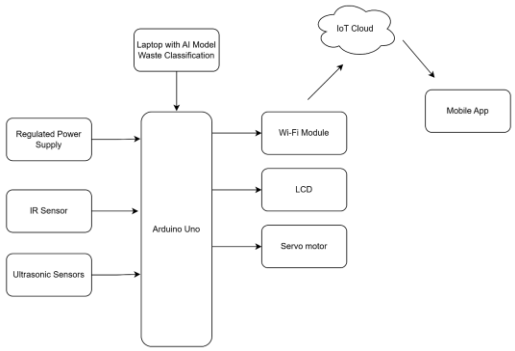

Fig 1 Block Diagram

5.IMPLEMENTATION

Automate Waste Classification: Use AI to classify waste into recyclable and non-recyclable categories.

Automate Waste Sorting: Employ servo motors to move waste to designated bins.

Monitor Bin Levels: Use ultrasonic sensors to measure and report bin fill levels.

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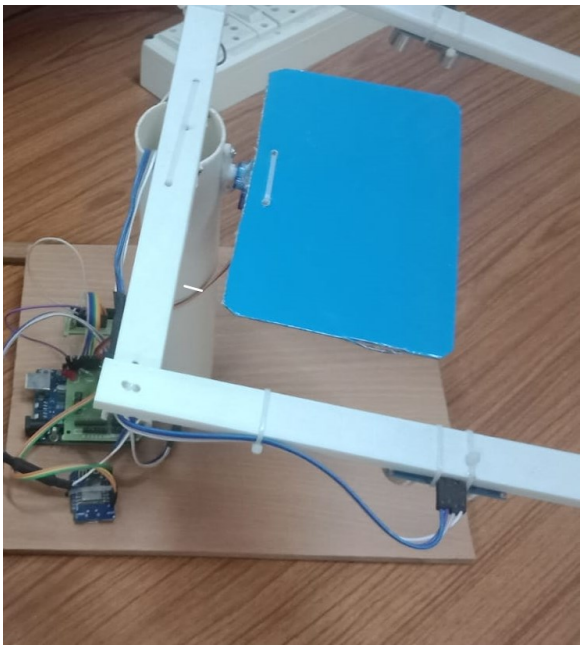
Enable IoT Connectivity: Transmit real-time bin status to the cloud and notify users through a mobile app.

Promote Sustainability: Facilitate efficient recycling and reduce human effort in waste management.

6. RESULTS



7. CONCLUSION

This project demonstrates the potential of combining AI and IoT to address waste management challenges. By automating waste segregation and monitoring, the system reduces human effort, promotes recycling, and enhances operational efficiency. Future enhancements could include multi-category waste classification and energy optimization using renewable sources.

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