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EMPOWERING MUNICIPALITIES WITH AI-BASED FRAMEWORKS FOR WASTE HANDLING AND MONITORING SYSTEMS

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Abstract: Trash is a residual object that no longer used anymore. Usually, it was a result of some process, which is by a human doing or natural ecosystem. This organic waste usually likes leafage and animal carcasses. On the other hand, non-organic waste is hardly decomposed by the organism. Regular trash removal enhances the visual appeal of neighborhoods and public spaces, contributing to a cleaner and more pleasant environment. Therefore, trash classification attracted a lot of researchers recently is also a promising application of computer vision in the industry. In this project, Camera Vision Based Trash Classification and Detection System Using Deep Learning are introduced. TrashAI aims to revolutionize this process by incorporating cutting-edge computer vision techniques to classify and detect trash items in real-time. This solution not only enhances the efficiency of waste management but also contributes to environmental sustainability.

Keywords: Smart Waste Management ,Trash Classification ,Convolutional Neural Networks (CNNs),Temporal Convolutional Networks (TCNs),Real-time Waste Detection

I. INTRODUCTION

Trash, Garbage, rubbish, or refuse is waste material that is discarded by humans, usually due to lack of utility. Garbage includes waste materials like kitchen or food scraps, boxes, tin, wood, paper etc. which is not of use by the humans. Indians generated 262 million tons of trash in 2015 (called "municipal solid waste," or MSW, as municipalities are the ones who haul and manage the stuff). That means generated 4.40 pounds of trash per person per day. To add some perspective, in 1960 generated only 2.68 pounds per person per day, so our consumption habits today are about 80 percent more wasteful than they were then. While the overall waste volume has increased, the percentage of materials being recycled stayed fairly level over the past few years at about 34 percent.

Sources of Trash

Sources of trash can be broadly classified into four types: Industrial, Commercial, Domestic, and Agricultural.

- **Industrial Trash**

  These are the wastes created in factories and industries. Most industries dump their wastes in rivers and seas which cause a lot of pollution.

  Example: plastic, glass, etc.

- **Commercial Trash**

  Commercial wastes are produced in schools, colleges, shops, and offices.

  Example: plastic, paper, etc.

- **Domestic Waste**

  The different household wastes which are collected during household activities like cooking, cleaning, etc. are known as domestic wastes.

  Example: leaves, vegetable peels, excreta, etc.

- **Agricultural Trash**

  Various wastes produced in the agricultural field are known as agricultural wastes.

  Example: cattle waste, weed, husk, etc

  .

Types of Trash

Commonly waste is classified into two types: Biodegradable and Non-biodegradable trash.

These two kinds of trash are explained below:

- **Biodegradable Trash**

  These are the wastes that come from our kitchen and it includes food remains, garden waste, etc. Biodegradable waste is also known as moist waste. This can be composted to obtain manure. Biodegradable wastes decompose themselves over a period of time depending on the material.

- **Non-biodegradable Trash**

These are the wastes which include old newspapers, broken glass pieces, plastics, etc. Nonbiodegradable waste is known as dry waste. Dry wastes can be recycled and can be reused. Non-biodegradable wastes do not decompose by themselves and hence are major pollutants.

II.METHODOLOGY

1. **Municipality Web App:** The Municipality Web App serves as a centralized platform for efficient waste management**.** Designed for administrators and officers, it provides a user-friendly interface for comprehensive management of the entire waste management system.This platform facilitates real-time monitoring, data analysis, and decision-making to enhance the overall effectiveness of waste management strategies.
2. **TrashNet: Build and Train:**

   2.1 Dataset Collection: The first step involves collecting a diverse dataset comprising images of various trash types. This dataset serves as the foundation for training the TrashNet model.

   2.2 Import Dataset: Import the collected dataset into the system, preparing it for further processing and model training.

   2.3 Preprocessing: Apply preprocessing techniques, including greyscale conversion, resizing, noise filtering, and binarization, to optimize the dataset for effective model training.

   2.4 Trash Detection: Utilize a Region Proposal Network (RPN) to detect trash objects within the preprocessed images, laying the groundwork for accurate identification.

   2.5 Feature Extraction: Extract relevant features from the detected trash using a fully connected layer, incorporating Gray Level Co-occurrence Matrix (GLCM) for enhanced feature representation.

   2.6 Build and Train: TrashNet: Develop the TrashNet model using Convolutional Neural Networks (CNNs) and train it on the processed dataset. This step ensures the model's ability to accurately classify diverse trash types.

   2.7 Deploy Model: Implement the trained TrashNet model for practical use, integrating it seamlessly into the waste management system.
3. **Trash Detector:**

   3.1 Live Video Feed from Municipality CCTV Camera: Access live video feeds from municipality CCTV cameras to provide real-time monitoring of waste management areas.

   3.2 Trash Prediction: Utilize Temporal Convolutional Networks (TCNs) for real-time trash prediction with TrashNet Model, enhancing the system's ability to dynamically identify and respond to changing waste scenarios.
4. **Trash Segregator:** Implement an intelligent trash segregator that categorizes detected waste items into color- coded bins. This step streamlines the sorting process for more efficient waste management.
5. **Alert Generator:** Automatically generate and dispatch alerts via SMS and email to municipality officers, ensuring immediate awareness and timely responses to critical waste management events or issues.
6. **End Users:**

6.1 Admin: The administrator serves as the primary manager, overseeing and directing the entire waste management system. This role involves monitoring system performance, analyzing data, and making informed decisions to optimize waste management strategies.

6.2 Municipality Camera: Municipality cameras provide access to live video feeds and system alerts. This interface Allows users to actively engage with the system, responding to real-time events and contributing to effective waste management practices.

III.SYSTEM ARCHITECTURE

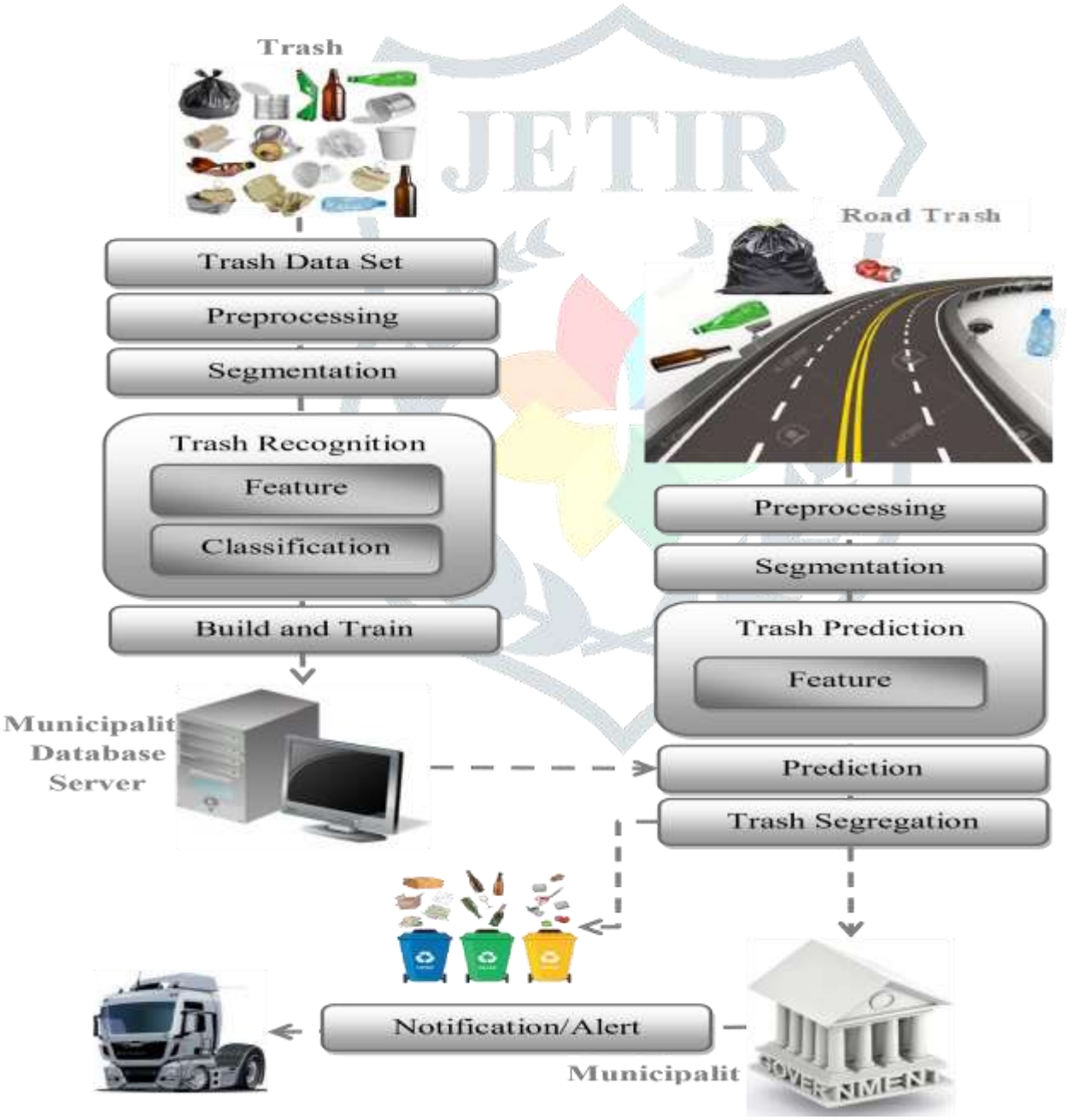

Figure 1. SYSTEM ARCHITECTURE

IV.RESULT AND DISCUSSION

Result :

The proposed solution utilizes Convolutional Neural Networks (CNNs) for precise waste classification and Temporal Convolutional Networks (TCNs) for real-time detection and adaptation to dynamic waste patterns. This integration enables intelligent segregation of waste at the source, reducing contamination and minimizing manual intervention. By automating waste management processes through advanced technologies and a Municipality Web App, the system enhances operational efficiency, reduces human error, and promotes sustainability.

Discussion:

The integration of Convolutional Neural Networks (CNNs) and Temporal Convolutional Networks (TCNs) offers a promising solution to the challenges of waste management in urban areas, enabling precise classification and real-time detection of waste. This advanced approach minimizes human error and contamination between waste streams, while allowing the system to adapt to

changing waste patterns. The use of a Municipality Web App further enhances decision-making, optimizes operations, and fosters sustainable practices, marking a significant step toward more efficient, environmentally-conscious urban waste management.

V.CONCLUSION

In conclusion, the TrashAI project represents a groundbreaking initiative in waste management, leveraging advanced technologies to revolutionize the way we handle and categorize waste.

By combining the power of Convolutional Neural Networks (CNNs) and Temporal Convolutional Networks (TCNs), our system, comprising the Municipality Web App, TrashNet, Trash Detector, Trash Segregator, and Alert Generator, offers a comprehensive solution for municipalities seeking to enhance their waste management practices.

TrashAI project is not just a technological advancement; it is a step towards fostering environmentally conscious practices, promoting sustainability, and contributing to a cleaner and healthier future.

With scalability, adaptability, and continuous improvement at its core, TrashAI is poised to redefine waste management practices, making them more efficient, intelligent, and responsive to the evolving needs of municipalities and communities.

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