Garbage Bin Overflow Detection Using YOLOv8

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Abstract: Overflowing trash containers present extreme health threats, unsafe living conditions, and offensive odors which present vexatious urban concerns. The antiquated practice of service checking at trash receptacles does not yield timely and sufficient results in the area of refuse management. The current research studies a real time trash overflow detection application in which is utilized a Flask based Python web application in combination with deep learning based developed trash detection via YOLOv8 video input. While video frames are analyzed and trash receptacles which are overflowing filled with trash are located, alerts are given to local trash authorities. In order to maintain an adequate amount and quality of input for neural network application, are employed video frame input processing controls via OpenCV and management via Roboflow. The application provides for positive trash management, improves upon environmental sustainability, and decreases human interaction in regard to trash conservation by means of the automation of trash monitoring. The application provides for increased operational efficiencies, maximization of resources, and creation of cleaner and healthier and more sustainable cities. In addition, the application improves community awareness in regard to trash overflow problems by informing citizens of filled trash receptacles, and it provides for predictive analysis in regard to optimal trash pick up scheduling.

Keywords: Trash Detection, YOLOv8, Video Input, Flask Web Application, Deep Learning, Smart Cities, Sustainable Trash Management.

I. INTRODUCTION

All cities create much more solid waste because their populations are increasing so quickly. Because of this, garbage cans are overloaded, which makes the area dirty, and smells foul [1]. These situations are not good for the environment and threaten the sanitary conditions of the residents living there, and for workers who are employed in sanitation. Traditional waste collection systems, which have always needed a great deal of human monitoring, are inefficient for many reasons. The inability to check bins that are full in a timely manner, results in rubbish being left on the streets, and makes it more difficult to keep cities clean [2].

Modern technology is making it possible to improve waste monitoring procedures through automation. By applying video data take-offs of garbage bins, it is possible to be alerted of the evidence of their overflowing status, while efficient cleaning will result, and the need for human assistance will be lessened [3]. The use of image variations developed in conjunction with the use of artificial intelligence lead to object detectors that allow government authorities to define the state of the bins, lessen errors in their operations, and expedite responses, which make for more sanitary and safer cities. Artificial intelligence and computer sight are a most important part of the automated monitoring process. Important object detection executions, e.g. YOLOv8, are playing a large and vital role in processing film bee solutions for the detection of overflowing bins [4]. A process involves the processing of frames of the video data taken from the bins in question, and working out whether the bins should be checked or not, and the sending of alerts through a web system are not dispensed with instant knowledge to the authorities, which are easily possible for them to monitor many locations easily, more efficient employment and reduction of rubbish will result.

The proposed system uses YOLOv8 for detection of garbage overflow integrated into the back-end base created with Flask and a front-end created with HTML, CSS and JavaScript. The video frames are pre-processed by OpenCV and handled by Roboflow, which deliver high quality input used by the AI model.The system constantly reads the video input and monitors the fill levels of the bins, which provides real-time notifications to the municipal authorities whenever overflow is detected [5].

Through automation, waste management evolves from a reactive to a proactive function, enhancing urban cleanliness .The prompt detection of overflowing bins likewise supports environmental sustainability in addition to the public health. Overflowing bins contribute to vectors and act as breeding grounds for bacteria and the like, which can pose health hazards. A concerted monitoring reduces these vectors and enhances cleanliness.AI-based monitoring of waste promote many effective collection strategies in cities, contributing to improved operational planning and decrease of environmental degradation.Integral AI-based object checking with web monitoring performs well in that real-time alerts can be made about garbage bins needing collection, lessening human intervention and improving operational efficiency. This represents a step in the direction of smart cities, where technology dominates repair of cleanliness or public health. In addition, it supports community participation by informing citizens of overflowing garbage bins or collection schedules with a view to promoting proper garbage practices and decreasing littering. This automated garbage detection makes it possible for the municipal authorities to effectively allocate resources. By pinpointing the bins requiring attention, collection routes may easily be modified, thus reducing fuel and operational costs [1]. Ongoing monitoring and evaluation will provide vital information upon the trends of waste production in preparation for creating a proper waste system in cities, and supporting further education efforts upon the need for education, and necessary policies to develop [2]. Using predictive analytics on the amassed video data facilitates authorities to anticipate overflow tendencies and consequently allocate resources pre-emptively.This allows for the most efficient waste management while reducing potential environmental dangers and promoting sustainable urban development.

I. RELATED WORKS

The problem of solid waste management is a major issue for cities, as traditional methodologies use manpower for inspection of waste in places, and inspection methods requiring periodic inspections. These methods do not deal adequately with fast growing cities, and cause delays in collection, environmental pollution, and health hazards through unhygenic conditions. Therefore, researchers have indicated that intelligent systems should be built to provide users with timely information for overflow situations of garbage bins, and opportunities for real-time monitoring of waste [1][2].

With recent advances made in the areas of artificial intelligence and computer vision, automated methods for waste monitoring are possible utilizing video. Various vision-based systems including utilization of deep learning technologies can be applied to larger areas to view the conditions of garbage bins in relation to type (overflowing) and size. These video-based systems are less physically demanding than methods based on sensor monitoring methods, and therefore can be adapted to larger areas in competitors. Models such as YOLO have great success with high accuracy and speed and methods of object detection, and in the field of waste management provide near-real time methods of identifying overflowing bins and notification of authorities for follow up investigations.

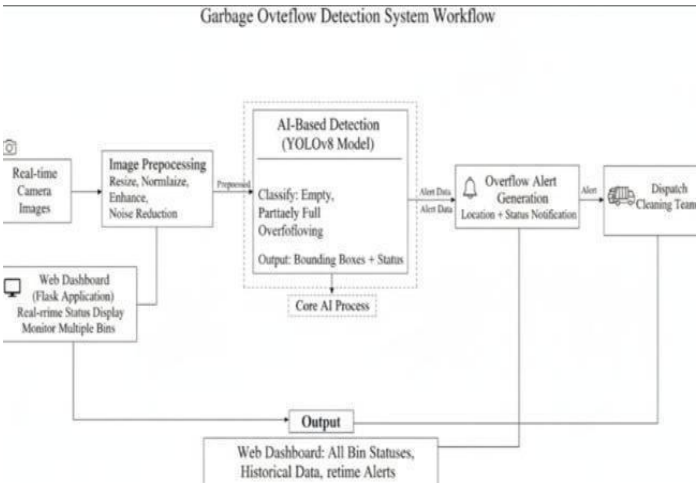
With the use of web-based platforms such as Flask for backend, and HTML/CSS/JS for frontend, poor visibility of waste conditions is possible to be communicated to waste management authorities, and allows for concurrent views of a wide region of waste management operations and conditions of waste in cities, which can increase the efficiency of operations and inspections of waste and allow a timely and appropriate response from authorities [2].

Automated video-based garbage monitoring have numerous advantages, including optimal allocation of resources, predictive analytics for collection routes, less human effort and improved public health. Continuous data gathering enables cities to analyze the trends of waste generation, adequate planning of infrastructures and promotion of sustainable urban development. To sum up, the combination of modern deep learning with video monitoring and web alert systems represents a good robust scalable and proactive technology that answers to the current problems of urban waste management [1][2].

Also several studies have shown the advantages of the integration of AI based object detectors with web applications for municipal services. Such systems enable not only the automation of repetitive monitoring tasks but also the usability of data through meaningful data analysis. If authorities analyze trends of use of the bins to be able to define with greater efficiency the schedules of collection and able to introduce in the matter determine smart plans of urban waste managements [3][4].

II. SYSTEM DEVELOPMENT

The suggested system uses a YOLOv8 deep learning model to automatically detect overflowing garbage bins taken from non-stop video streams. The video frames are processed in OpenCV and handled using Roboflow to make sure good quality data input.



The system is supported by a Flask based backend for real time alerts and has an HTML/CSS/JS front-end to give authorities an interactive monitoring dashboard.

Figure: 3.1

SYSTEM WORKFLOW

Step 1: Video Input: The first step in the process is when the user introduces the system to a video feed. This can either be done by uploading a recorded video file or through the "Capture from Camera" option, which collects live footage.

Step 2: Frame Processing: This video feed is separated, and processed in frames. The video frame is preprocessed for frame rate, size, and view so that the images are standard so that a standardized study of that image can be done by the AI.

Step 3: Object Detection: In this phase the preprocessed frames are pushed to the YOLOv8 deep learning model which analyses the individual frame for correct detection & classification of data. The system, which is specifically looking for signs of a trash can in an overflowing state, searches for those figures that denote garbage can and overflow in them.

Step 4: Output & Alert: When the model detects that a garbage can is overflowing it outlines it with a bounding box around the object and identifies it with a label, typically "Trash overflow." This figure recorded and its confidence will trigger an alert which is delivered to the authorities and appears on the web dashboard. This leads us to the conclusion that the project entitled "Video based method of garbage bin overflow detection" is formed into a product to be marketed as a garbage bin overflow detection system which uses YOLOv8 and video capture to monitor non-recyclable waste collection as well as a method of pre-processing of video input and its use as a garbage collection detection system.

Timely alerts via a flask-based web solution is an efficient automated intervention by municipal authorities, the use of live pictures and alerts helps in a better availability of waste as well as better results. Improved efficiency for management, allocation of authority resources and ultimately more clean and healthier urban living.

III. PERFORMANCE ANALYSIS AND RESULTS

A. Garbage Overflow Detection using YOLOv8

The suggested solution employs a YOLOv8 model for automatic detection of overflowed garbage bins from live video streams. For the video frames, OpenCV preprocessing is done and the trained model by Roboflow is capable to classify the garbage bins. This will enable real-time notifications to be sent about their state for municipal bodies.

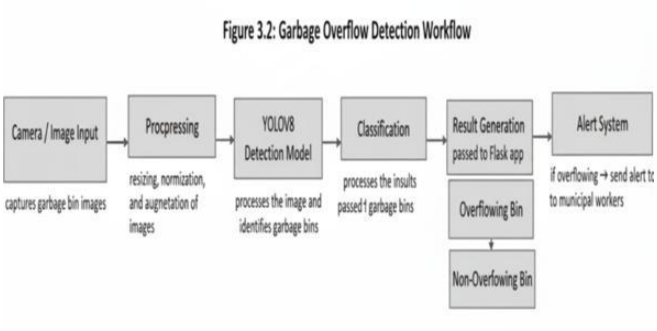


Figure: 3.2

B. Flask Web Application Integration

The user interface is built with the Flask framework. providing a real-time dashboard for monitoring bin status.

This allows workers to view live feeds, assess detection results, and maintain historical records for analysis. The integration ensures that all data is accessible and actionable

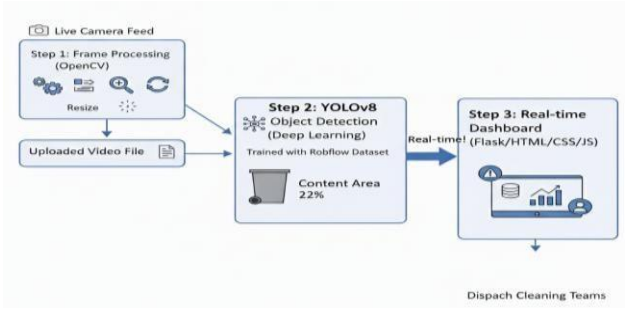
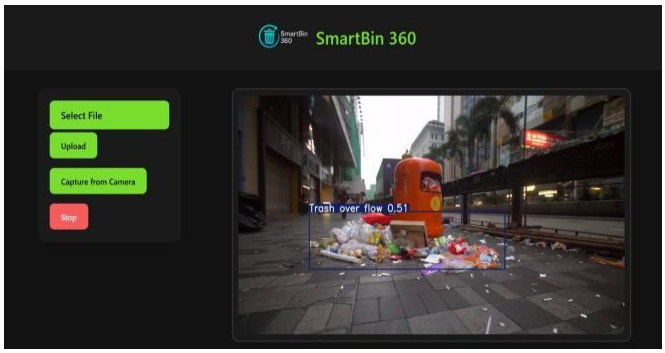


Figure: 3.3

RESULTS

For reporting and monitoring the status of bins through a live dashboard interface, the user interface has been created using



The Flask framework. Figure 4.2 This system allows the employees to view the live feeds, view the results of the detection and the historical data for their study. This interface guarantees that all the data is obtainable and actionable..

Figure: 4.1

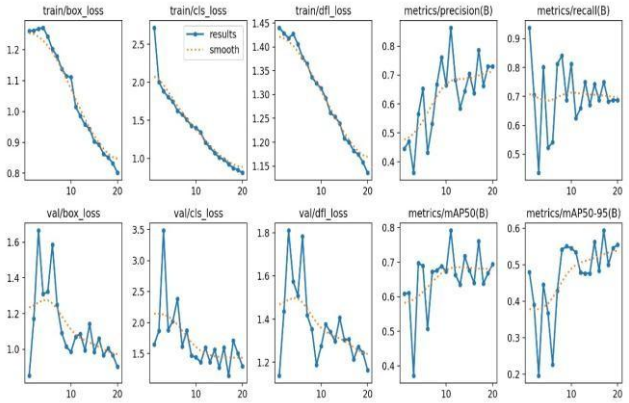


Figure: 4.2

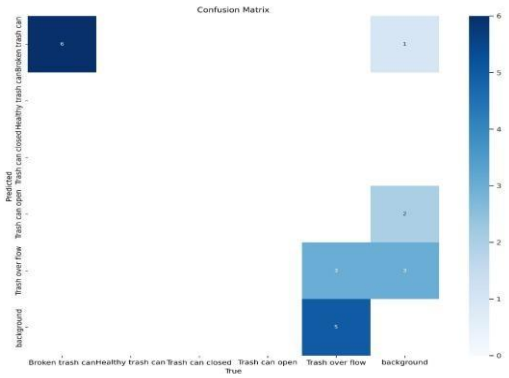


Figure: 4.3

The Flask-based web application provided a dashboard in real-time and generated alerts automatically to overflowing bins, increasing the operational efficiency involved and making possible a proactive management of waste collection.

The scalability of the system was demonstrated by monitoring a plurality of bins at the same time, keeping historical records of utilization for analysis purposes and making possible the implementation of data-driven city waste storm management strategies.

V. CONCLUSION AND FUTURE SCOPE

The proposed waste bin overflow detection system showcases the innovative use of computer vision and deep learning to meet real-life problems in urban waste management. The YOLOv8 object detection model is used to classify the image data preprocessed using OpenCV and trained on the Roboflow dataset.

The relevant image data can be classified into either overflowing bins or non-overflowing bins using the proposed model. The new system can be integrated into a Flask-based web application, which is programmed through Python and allows municipalities to obtain results in real time concerning overflow in chosen bins and the simultaneous viewing of multiple bin situations. This fashion of automation greatly curbs the requirement of human knowledge to inspect every bin and leads to increased effective operations regarding waste control, thus giving rise to cleaner towns, better public health and welfare, and a sustainable city environment.

The new system is also scalable and can be modified in many ways, as new and better forms of the YOLOv8 program such as Deformable Attention (DAT) can augment the system capabilities considerably in the domain of efficiency and detection possibility. Furthermore, this project presents new relevance to the concept of proactive waste management and the innovative application of technologies to give the required climate for the growth of smart cities. The combination of AI detection, web-based dashboard systems, and automated alert generation gives rise to a solid, easily usable, and efficient data-driven based system that can give rise to wastelands become minimized, a less hazardous health situation existing, municipal man hours and funds saved and satisfactory use of municipal resources.

Overall it represents a strong, efficient and easily scalable method for modern urban waste control it is anticipated that many improvements will be included in the new system going into the future including the intergration of predictive analytics and machine learning type of optimimization of collection routes.

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