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Smart Waste Management System

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Abstract

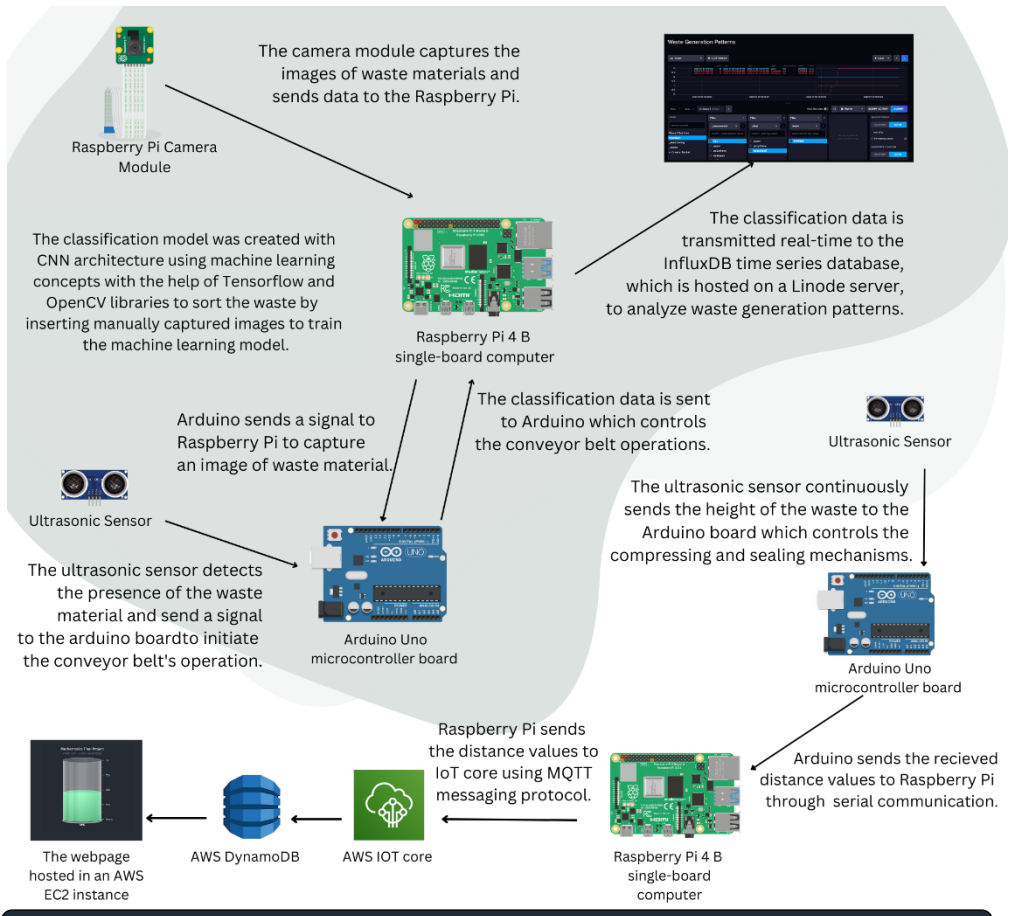
The proposed system utilizes image classification technology to analyze the visual characteristics of waste items. An integrated camera captures images of the waste, which are then classified into different categories and directed towards the relevant bin. Then, the system incorporates an automated compressing and sealing mechanism, aiming to optimize waste management by reducing the volume of waste, thereby maximizing storage efficiency. Additionally, the system includes a real-time monitoring system and a waste generation pattern analysis.

Introduction

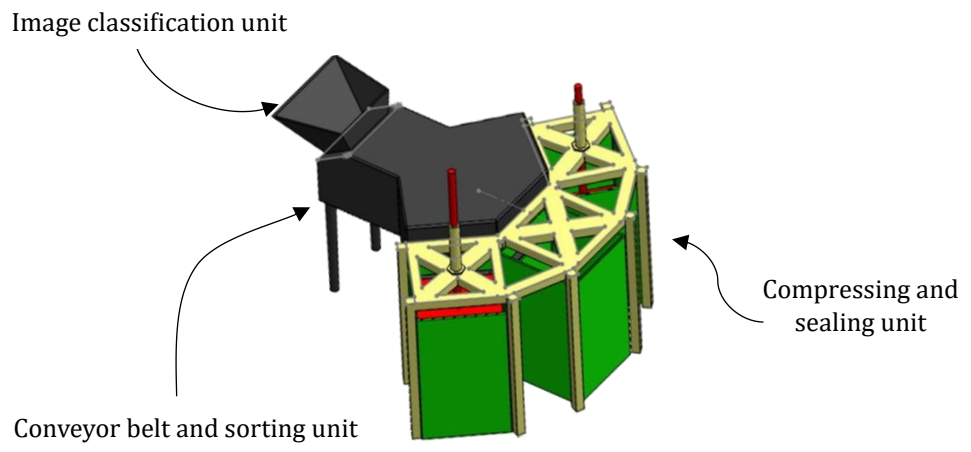
The system is designed to automate waste sorting with remarkable efficiency utilizing image classification on a Raspberry Pi, ultrasonic sensors for level measurement, and servo-controlled mechanisms for efficient waste compression and polythene bag sealing, making waste disposal smarter and more sustainable.

- In the Raspberry Pi OS, a Python virtual environment was set up, with essential libraries like TensorFlow, OpenCV-Python, Matplotlib, and NumPy installed. For training the machine learning model to classify images, a dataset of 352 images was collected, comprising four distinct classes: waste food, polythene, paper, and a null category. The classification process employed CNN architecture and the sequential API.
- Once classified, the garbage is transferred onto the conveyor belt using a Stepper motor. With instructions from the Raspberry Pi, a slider guides the garbage into the appropriate bin, whether it is for paper, polythene, or waste food.
- In the compressing and sealing unit, an ultrasonic sensor to regularly measure the distance to the garbage. Once the garbage level reaches a specific threshold, the system activates the lead screw mechanism to compress the waste efficiently. When the container reaches its maximum capacity, the sealing unit takes action, sealing the polythene bag securely.
- Meanwhile, the real-time distances of the waste bins were transferred through an Arduino microcontroller board to a Raspberry Pi board, then the distances were transmitted through the MQTT messaging protocol to the AWS IoT core, again fetched to the AWS DynamoDB NoSQL database, and then represented in a webpage that was hosted in an AWS EC2 instance.
- Additionally, the classification data is transmitted real-time from Raspberry Pi to the InfluxDB time series database, which is hosted on a Linode server, to analyze waste generation patterns.

Methodology



Project Design



Conclusion

Our waste management system holds paramount importance in addressing the pressing global issue of waste management. By utilizing image classification, it enhances waste sorting accuracy, reducing the burden on manual labor and improving recycling rates. The Ultrasonic sensors enable real-time monitoring of waste levels, optimizing waste collection schedules, and preventing overflows. Moreover, the efficient compression and sealing mechanisms not only save space but also reduce environmental hazards, promoting cleaner surroundings and fostering a greener and more sustainable future for generations to come.

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