BinSense – Efficient waste management through IoT technology

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1. Introduction

In today's society, we are facing increasing challenges in waste management, especially in urban areas. I have noticed a growing number of overflowing garbage bins throughout the city, which creates additional problems such as untidy streets and unpleasant odors. To better understand this issue, research highlights that economic growth and increase in population are key factors in waste generation in any economy. This research indicates that the increase in waste is directly linked to the rate of urbanization and economic progress [1]. This data emphasizes the urgent need for more efficient waste management systems that can adequately respond to the growing demands of urban life, including our experience with overflowing bins and their undesirable consequences on our environment.

This research aims to apply Internet of Things (IoT) technology to make waste collection more efficient in urban environments. Through the implementation of IoT devices in garbage containers, I want to enable continuous monitoring of the fill levels of the containers. This will allow us to identify patterns in waste generation, optimize garbage collection routes, and reduce unnecessary costs and carbon dioxide emissions in the waste management process. Internet of Things technology offers an efficient and cost-effective solution for monitoring the fill levels of containers. IoT devices are affordable and easy to install, making them ideal for widespread use in urban environments [2].

2. Material and Methods

The idea of this project is to develop an IoT device that can be integrated into garbage containers to continuously measure the level of waste. For the project testing phase, the device will be adapted for use on a standard household bin. The project consists of two parts: the IoT device and the software solution for accessing data from the bins. The core of the IoT device is the Raspberry Pi 4B board, along with the Arduino US-100 ultrasonic distance sensor, which enables quick measurement of how full the bin is. For the software solution on the IoT device, Python was used, along with additional libraries such as RPi.GPIO (for accessing the sensor itself, connected via GPIO pins), and the Requests library for sending data to the server [3][4]. To ensure secure communication and data protection, a Virtual Private Network (VPN) was created to allow devices to access the central server without enabling access to the server outside the private network. The VPN enables encrypted communication between devices and the server. The server can be divided into two parts: an API for data and a web solution for device access. The API is implemented using the Flask framework, allowing communication between the central server and IoT devices, while MySQL is used for storing data. The web application utilizes HTML, CSS, and JavaScript.

3. Results and Discussion

During the project development, I decided to test the system by implementing it in my own home. One IoT device was installed in the kitchen. The device accurately measured the fill level of the bin, allowing me to continuously monitor how full it was. The web interface enabled me to see where the bin was installed and how full it was. The system automatically issued a warning if the bin was filled over 70%. The system administrator has the option to change when/if the warning will be issued. Additionally, the system alerts if the garbage has been in the bin for more than a week. For further system testing, I introduced simulated devices. Simulated devices allowed me to test the web interface for multiple devices.

4. Conclusion

For a project of minimal value, the idea was to create a device and corresponding system to facilitate waste management. The project fulfills its objective. In the future, I plan to expand this project by adding automatic generation of optimized waste collection routes, as well as implementing machine learning to estimate when the bin will be filled.

5. References

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