CAPSTONE PROJECT

SMART WASTE MANAGEMENT

PRESENTED BY

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OUTLINE

- **Problem Statement** (Should not include solution)
- **Proposed System/Solution**
- **System Development Approach** (Technology Used)
- **Algorithm & Deployment**
- **Result (Output Image)**
- **Conclusion**
- **Future Scope**
- **References**

PROBLEM STATEMENT

The increasing population in urban areas has led to a rise in solid waste production.

Most municipalities follow fixed-time garbage collection schedules regardless of the actual waste levels in bins.

This results in two major problems: overflowing bins that pose health risks, and empty bins being collected unnecessarily, leading to inefficient resource use.

PROPOSED SOLUTION

- The proposed system uses IoT sensors to monitor garbage bin levels and machine learning to predict the fill time of each bin.

- **Key Features:**
- - Ultrasonic sensors installed in bins measure garbage level in real-time.
- - Data is transmitted via Wi-Fi to a central cloud-based system.
- - A machine learning model predicts when bins will be full.
- - A dashboard displays the fill status and generates alerts for municipal workers.

- This helps in optimizing collection routes, saving fuel, time, and ensuring a cleaner environment.

SYSTEM APPROACH

System Requirements:

- NodeMCU ESP8266 microcontroller
- Ultrasonic Sensor (HC-SR04)
- Wi-Fi connectivity (via hotspot or router)
- Firebase or ThingSpeak for cloud data storage
- Python for ML model and dashboard
- Web dashboard built using Flask

Libraries/Tools Used:

- Python: pandas, numpy, sklearn, matplotlib, seaborn
- Arduino IDE for programming NodeMCU
- Firebase Realtime Database for real-time monitoring

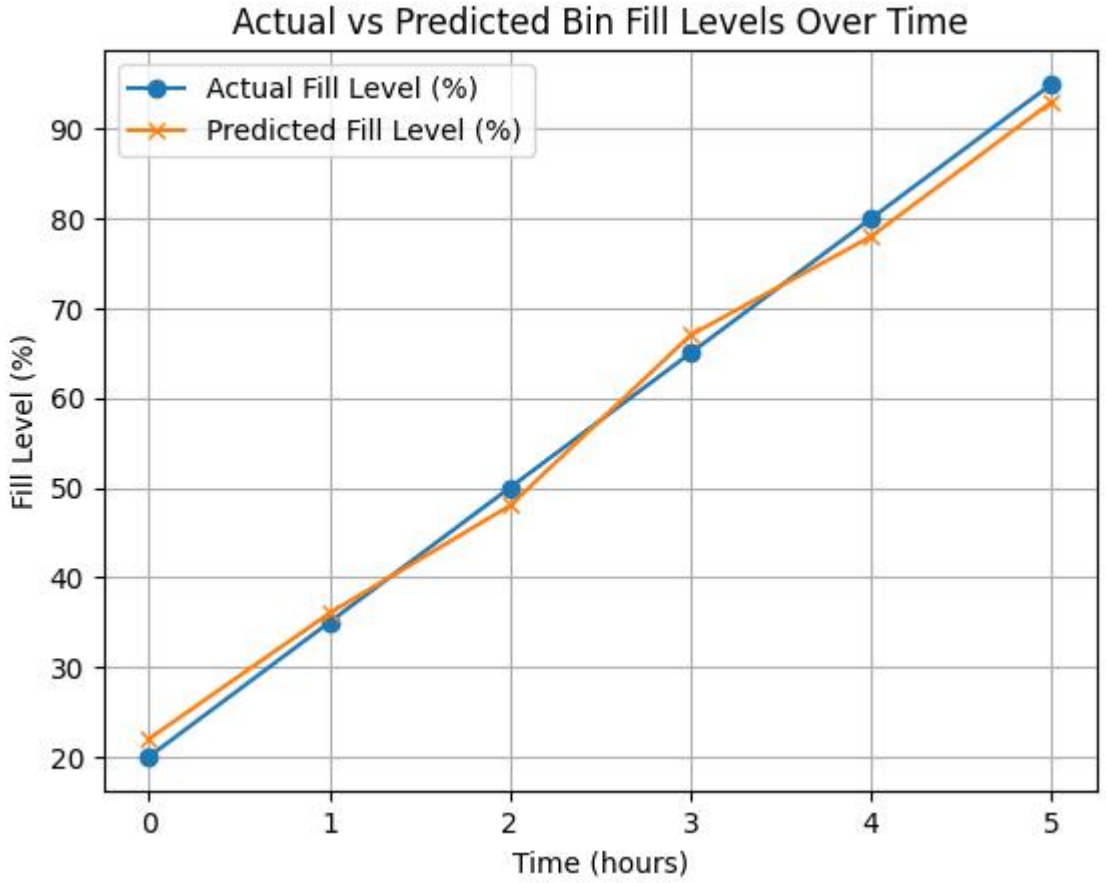
ALGORITHM & DEPLOYMENT

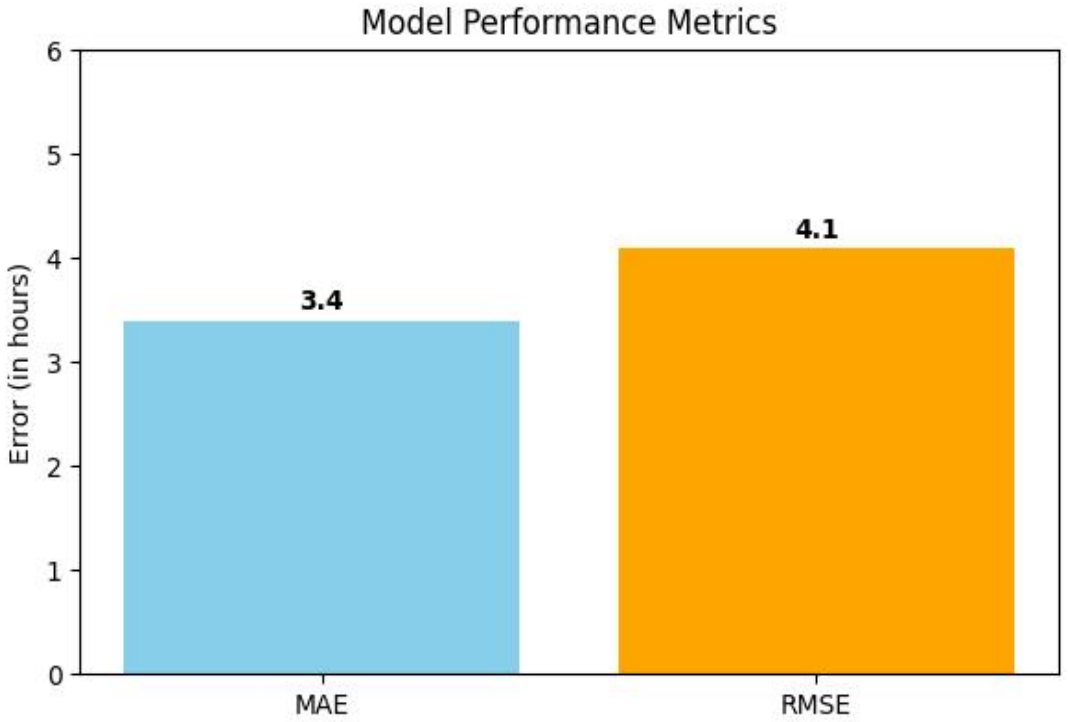
- **Algorithm Selection:**
- - Linear Regression model chosen due to its efficiency in predicting continuous numerical values (i.e., time to fill bins).
- - Input Features: Previous fill levels over time, location of the bin, average disposal rate.

- **Training:**
- - Data collected from sensors every hour and stored in Firebase.
- - Cleaned and trained using scikit-learn.
- - Split data into training and test sets for evaluation.

- **Deployment:**
- - The trained model is hosted in a Flask app.
- - Dashboard displays bin locations, current fill % and estimated full time.
- - Alerts are sent when bins are about to overflow.

RESULT


Actual vs Predicted Bin Fill Levels Over Time
Actual Fill Level (%)
Predicted Fill Level (%)
Fill Level (%)
Time (hours)
20
30
40
50
60
70
80
90
0
1
2
3
4
5


Model Performance Metrics
Error (in hours)
0
1
2
3
4
5
6
3.4
4.1
MAE
RMSE

RESULT

Smart Waste Management Dashboard

Bin ID	Location	Fill Level (%)	Predicted Full Time	Status
Bin 1	Main Street	78	2 hours	Almost Full
Bin 2	Market Square	92	30 minutes	Overflowing
Bin 3	School Road	45	5 hours	Normal
Bin 4	Hospital Lane	63	3.5 hours	Almost Full
Bin 5	Temple Street	85	1 hour	Almost Full
Bin 6	Library Avenue	52	4 hours	Normal
Bin 7	Tech Park Gate 2	96	15 minutes	Overflowing
Bin 8	University Hostel Road	68	2.5 hours	Almost Full
Bin 9	Central Bus Station	88	50 minutes	Overflowing
Bin 10	City Mall Parking	39	6 hours	Normal
Bin 11	Green Park	42	5.5 hours	Normal
Bin 12	East Side Plaza	77	2 hours	Almost Full
Bin 13	West End	60	3 hours	Normal
Bin 14	South Gate	55	3.8 hours	Normal
Bin 15	North Station	90	45 minutes	Overflowing
Bin 16	Riverfront	48	5 hours	Normal
Bin 17	Hilltop Road	35	7 hours	Normal

CONCLUSION

The Smart Waste Management System successfully addresses the inefficiencies in traditional garbage collection.

Key Benefits:

- Reduces manpower and fuel costs
- Prevents overflowing bins
- Enables data-driven decision making

The combination of IoT and machine learning can be scaled to multiple cities, contributing to smart and sustainable urban living.

FUTURE SCOPE

- Integration of route optimization using Google Maps API to further reduce travel time.
- Expand system to segregate waste types (plastic, organic, metal).
- Use of solar-powered sensors for environmental sustainability.
- Integrate anomaly detection (fire or bin tampering) using computer vision.

Long-term vision includes deployment in smart cities and integration with municipal ERP systems.

REFERENCES

- Research Paper: “Smart Waste Management Using IoT” – IEEE, 2020
- Arduino.cc – Sensor and ESP8266 Documentation
- scikit-learn Documentation – Machine Learning Libraries
- Firebase Realtime Database – Cloud Data Storage
- GitHub : https://github.com/Divyasri4002/smart-waste-dashboard

Thank you