Bin-AI

We are developing a solution which will aid in solving the urbanization global challenge through a smart waste management system we called “bin-AI”. Bin-AI is an AI powered IoT based bin system –first of its kind.

The system consist of two proximity sensors (ultrasonic): one measures the trash level in the bin and the other monitor user approach. The bin also has a servo motor which opens the bin when users come to dump trash in the bin, this ensure that users were prevented from contacting germs as a result of direct contact with the bin. The bin has a GPS module that tract its location and a GSM module that enable it to communicate with the bin-AI server. The bin will be power by solar cells and batteries to ensure the bin stay alive 24/7 hours. The microcontroller in the system read the value of user proximity sensor to detect when to open and close the bin, while reading the trash level sensor to know the bin’s trash level. The value which is then send to the main server for trash picking company to monitor the level of each bin in the town.

Trash picking companies will be provided with user friendly web interface to monitor each bin they deployed. When a bin trash level is 70%, its marker color is change to amber for ease of identification and red at 90% with urgent alarm to the company.

The function of the AI is to study the frequency in which a bin are been filled in their deploy locality and provide a data driven insight for decision makers.

Bin system is design, implemented and simulated with Tinker CAD, C++ and Arduino. The system data is send to a Firebase NoSQL database. The data is read and analyze by AI which then provide a visualization to the authorities.

Public users can access the main webpage and see the entire deployed bins in the state. But only trash picking companies can register on the portal and login to their dashboard, where they can deploy a bin and monitor other bins deployed by them. A trash picking company must be a registered company with the corporate affairs commission (CAC) before their application be approve and given dashboard.

The bin is develop with C++ with ATMega328p microcontroller, servo motor, ultrasonic sensors, SIM900A GSM module and GPS module.

The web is developed with HTML, CSS and JavaScript and deployed with Google Firebase. Google Gemini LLM AI API will be used as the AI component.

The bin-AI project would provide a data house for waste management authorizes and town planners in decision making for building a safer and healthier urban cities.

Team members are as follows:

1. Lufiya Mahmud Faruk – 3MTT cohort 2 fellow from Bauchi under software development from Taibah Innovation Hub. Primary contribution to the project are: frontend web design and coding in HTML, CSS and JavaScript.
2. Babangida Yohanna – 3MTT cohort 2 fellow from Bauchi under software development from Taibah Innovation Hub. Primary contribution to the project are: the bin designed, C++ coding, and simulation in Tinker CAD.
3. ChatGPT –help in braining storming, project analysis, providing hints and guideline throughout the project life line.
4. Altogether –work in the deployment and product management setting.

We work collaboratively on GitHub and Google workspace tools.

A REDEFINE VERSION

**Bin-AI**  
The Bin-AI project addresses urban waste management challenges by introducing an AI-powered IoT-based smart waste bin system. This first-of-its-kind solution aims to create a cleaner, safer urban environment through efficient waste monitoring and collection.

**Project Overview**

Bin-AI integrates **two ultrasonic proximity sensors**: one to monitor trash levels and the other to detect user approach. A **servo motor** opens the bin lid when users approach, allowing touchless operation to minimize contamination risks. The system includes a **GPS module** for location tracking and a **GSM module** for real-time communication with the Bin-AI server. The bin is powered by **solar cells and batteries** for continuous 24/7 operation.

**Core Functionalities**

* **Real-Time Monitoring**: The microcontroller processes data from the user proximity and trash level sensors to determine when to open the lid and when to notify waste management.
* **Data Transmission**: Collected data is sent to a central server, where trash collection companies can monitor trash levels across the city.
* **Smart Alerts**: When a bin reaches 70% capacity, its marker changes to amber, and at 90%, it changes to red, triggering an urgent alert to the responsible company.
* **AI Analysis**: Bin-AI’s AI component uses the Google Gemini LLM API to analyze fill-rate data, providing authorities with insights into waste patterns for data-driven urban planning.

**Technology Stack**

* **Hardware**: ATmega328p microcontroller, servo motor, ultrasonic sensors, SIM900A GSM module, GPS module.
* **Software**: C++ (microcontroller programming), TinkerCAD (simulation), Firebase NoSQL (data storage and web hosting), HTML, CSS, JavaScript (web interface development).
* **AI Component**: Google Gemini LLM API for data analysis and visualization.

**User Access**

The public can view deployed bins on a main webpage, while trash collection companies can register, subject to verification by the Corporate Affairs Commission (CAC). Verified companies can log into a dashboard to deploy and monitor their bins.

**Team Roles**

1. **Lufiiya** Mahmud Faruk– Responsible for frontend design and coding in HTML, CSS, and JavaScript.
2. **Babangida Yohanna** – Leads bin hardware design, coding in C++, and simulation in TinkerCAD.
3. **ChatGPT** – Provides brainstorming, analysis, and guidance.
4. **Team Collaboration** – Deployment and project management are handled via GitHub and Google Workspace.

**Impact**

The Bin-AI system has the potential to transform urban waste management, offering municipalities valuable data for building cleaner, healthier cities through optimized waste collection and data-backed urban planning.