**Project Design Phase-II**

**Technology Stack (Architecture & Stack)**

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| Date | 28 June 2025 |
| Team ID | LTVIP2025TMID45505 |
| Project Name | CleanTech: Transforming Waste Management with Transfer Learning |
| Maximum Marks | 4 Marks |

**Technical Architecture:**

## **Technical Architecture Overview:**

The application aims to classify waste into Biodegradable, Recyclable, and Trash using a Transfer Learning model (VGG16). The architecture is modular and scalable, suitable for cloud deployment using Flask as backend, HTML/CSS for frontend, and integrated ML inference pipeline for prediction.

### ✨ Example Use Flow:

1. User uploads an image through web UI
2. Image is sent to backend Flask server
3. Pre-trained ML model (VGG16-based) processes and classifies the image
4. Result is returned to the UI and optionally stored in a cloud database

## **📘 Table 1: Components & Technologies**

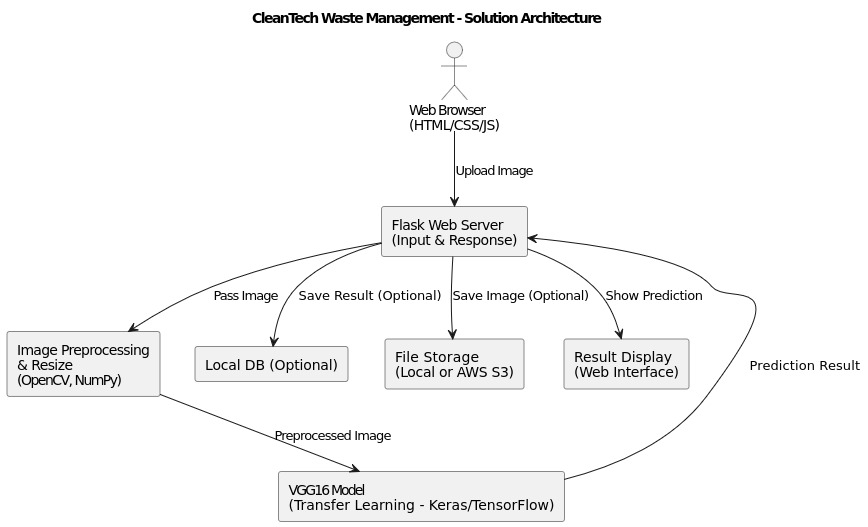
| **S.No** | **Component** | **Description** | **Technology** |
| --- | --- | --- | --- |
| 1 | User Interface | Web interface for image upload and viewing results | HTML, CSS, JavaScript |
| 2 | Application Logic-1 | Backend logic for handling requests and responses | Python, Flask |
| 3 | Application Logic-2 | Image preprocessing and resizing before model inference | OpenCV, NumPy |
| 4 | Application Logic-3 | Model prediction pipeline using Transfer Learning | TensorFlow, Keras (VGG16) |
| 5 | Database | Store classification results (optional) | SQLite (for local), MySQL (for cloud) |
| 6 | Cloud Database | Cloud storage of predictions | Firebase / AWS RDS (optional) |
| 7 | File Storage | Store uploaded images temporarily | Local File System or AWS S3 (optional) |
| 8 | External API-1 | To fetch waste category guidelines from government datasets | Swachh Bharat API (optional) |
| 9 | External API-2 | To fetch geolocation data based on IP | IPinfo API (optional) |
| 10 | Machine Learning Model | Image classification using VGG16 model | Transfer Learning – VGG16 (Keras/TensorFlow) |
| 11 | Infrastructure (Server) | Hosting the application on local server or cloud | Localhost / AWS EC2 / Render / Heroku |

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## **Table 2: Application Characteristics**

| **S.No** | **Characteristics** | **Description** | **Technology** |
| --- | --- | --- | --- |
| 1 | Open-Source Frameworks | Frameworks and libraries used in the project | Flask, TensorFlow, Keras, OpenCV |
| 2 | Security Implementations | Password-protected UI (if extended), input sanitization | SHA-256 Hashing (for login), HTTPS |
| 3 | Scalable Architecture | Modular microservice-style design with separate frontend, backend, and model | Flask (3-tier), Docker-ready |
| 4 | Availability | Easy deployment on cloud, can use load balancers for horizontal scaling | AWS/GCP load balancing, Heroku Dynos |
| 5 | Performance | Image resizing before prediction, model cached in memory for fast inference | Flask, TensorFlow serving, CDN for assets |

## **Sample Architecture Diagram**



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