Project Overview

This project focuses on leveraging modern technology to monitor and predict the spread of water hyacinths at the Hartbeespoort Dam. By combining web applications, predictive modeling, and mobile-based image detection, the system provides a comprehensive toolset for addressing the challenges posed by invasive aquatic plants. Below is a detailed breakdown of the project components:

Hosting Infrastructure

The system is hosted on a **Linux Ubuntu server**, utilizing **Apache2** as the web server to manage HTTP requests. This reliable and scalable setup ensures smooth operation of the website.
The back-end database is hosted using **PostgreSQL**, chosen for its robust support for complex queries and scalability. The database plays a crucial role in managing data related to weather conditions, hyacinth predictions, and user interactions.

Website Functionality

The website serves as the central hub for users to interact with the prediction model and access critical insights. Its key features include:

1. **Weather Data Visualization**
    - Users can view real-time and future weather data for the Hartbeespoort Dam.
    - This data includes parameters like temperature, humidity, and wind speed, which influence the movement and growth of hyacinths.
2. **Prediction Mapping**
    - The website features a prediction model that forecasts the movement of water hyacinths over a specific period.
    - Users can choose dates to view visualized predictions displayed on a map, allowing for strategic planning of interventions.

Mobile Application Integration

The mobile application plays a vital role in field operations, specifically in real-time detection and annotation of water hyacinths. Its key functionalities include:

1. **Image Detection**
    - The app uses advanced machine learning algorithms to detect water hyacinths in captured images.
    - These detections are marked directly on the images for clarity.

2. **Live Video Annotation**
    - The app processes live video streams, highlighting detected hyacinths in real-time.
    - This functionality supports on-the-ground monitoring and rapid decision-making.
3. **Data Collection**
    - The app collects images and video annotations and uploads them to the central server for further analysis or record-keeping.
    - This data helps in improving the predictive model over time.
4. **Camera Integration**
    - The app connects to a camera via an **IP address and port**, enabling users to connect to either a **drone** or a **phone** and use its camera for live detection and annotation of water hyacinths in real-time.
    - This flexibility allows for seamless integration with different hardware for effective monitoring.

Prediction Model on the Website

Unlike traditional machine learning-based models, the website's prediction system relies on **wind direction and speed** as the primary factors influencing hyacinth movement.

- **Wind Speed**: Determines how far hyacinths are likely to drift within a given timeframe.
- **Wind Direction**: Guides the path of movement across the dam.
- These inputs are used to calculate and map hyacinth drift patterns over time, displayed as interactive visualizations on the website.

Technical Highlights

1. **Server-Side**:
    - **Ubuntu Linux** and **Apache2** provide a robust hosting environment.
    - **PostgreSQL** handles database operations for storing and managing weather data, prediction results, and user interactions.
2. **Front-End**:
    - The website is designed with user-friendly, responsive frameworks for seamless access on various devices.

3. **Mobile Application**:
    - The app employs machine learning models for real-time detection and annotation of hyacinths.
    - Data collected by the app supports the improvement of predictive modeling.
4. **Camera Connectivity**:
    - The app connects to an **IP camera** or mobile device for live video annotation and detection. This provides flexibility for users to deploy drones or smartphones for real-time image capture in the field.

Impact and Utility

This system offers a strategic tool for managing water hyacinth invasions by:

- Providing real-time detection and long-term predictive insights.
- Supporting local authorities, environmental agencies, and stakeholders in making informed decisions.
- Promoting environmental conservation through advanced monitoring and planning.

Future Enhancements

- **Autonomous Drone Integration**: Implement drone automation for capturing real-time imagery at scale.
- **Advanced Prediction Models**: Incorporate additional environmental factors and historical data to refine forecasting accuracy.
- **Public User Access**: Introduce features for users to set alerts, and receive updates.

This project demonstrates a cutting-edge approach to integrating technology for ecological monitoring and predictive analytics at Hartbeespoort Dam.