Project Report

Digital Image Processing

Submitted to:

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Plastic Objects Detection System – Project Report

1. Introduction

This project focuses on **Plastic Objects Detection** using **YOLOv11**, a state-of-the-art object detection model. The goal is to automatically detect and classify different plastic items from images or live camera feed. This solution can be used for **waste management**, **recycling automation**, and **environmental monitoring**.

A **Streamlit web application** is also developed to make the model interactive and user-friendly. The app allows:

- Uploading an image for detection
- Viewing detection results instantly
- Running **real-time webcam detection**
- Showing the main interface of the application

This report explains the complete system, technologies used, workflow, screenshots, and outputs.

2. Objectives

The main objectives of this project are:

- To detect multiple types of plastic waste using YOLOv11
- To create a simple and interactive UI for end-users
- To allow real-time object detection using webcam
- To demonstrate the application of deep learning in environmental sustainability

3. Technologies Used

Deep Learning & Computer Vision:

- **YOLOv11** for object detection
- **OpenCV** for video streaming (webcam)
- **PyTorch** for model execution

Web App Framework:

- **Streamlit** for creating the web-based UI

Programming Language:

- **Python 3.10+**

Others:

- Numpy
- Matplotlib (for training visualization)

4. Concepts Used

4.1 Object Detection

Object detection identifies objects in an image and draws bounding boxes around them. YOLOv11 performs:

- Bounding box regression
- Class prediction
- Confidence scoring

4.2 Transfer Learning

The project uses pre-trained YOLOv11 weights and fine-tunes them on a **plastic waste dataset** to improve accuracy.

4.3 Streamlit Frontend Integration

The entire model is wrapped inside an easy-to-use Streamlit UI that supports:

- Image upload
- Real-time frame processing
- Displaying results inside the browser

4.4 Real-time Processing

Using OpenCV + YOLOv11, we process each frame from the webcam and return the predictions in real-time.

5. System Workflow

Step 1 – Data Acquisition

Dataset for plastic object detection is used from Kaggle with labeled plastic waste images.

Step 2 – Model Training

- YOLOv11 model is trained locally
- Custom dataset is used
- Final model weights (best.pt) are downloaded

Step 3 – Streamlit App Development

The application contains three modules:

1. **Main User Interface**
2. **Image Upload Detection**
3. **Real-time Webcam Detection**

Step 4 – Deployment

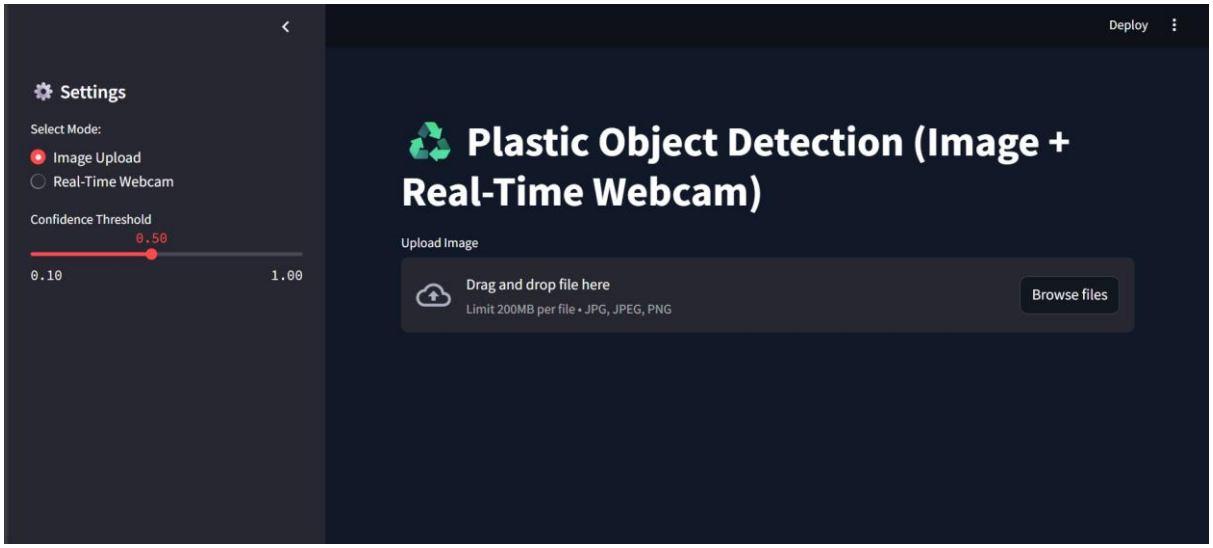
The app runs locally using:

```
streamlit run app.py
```

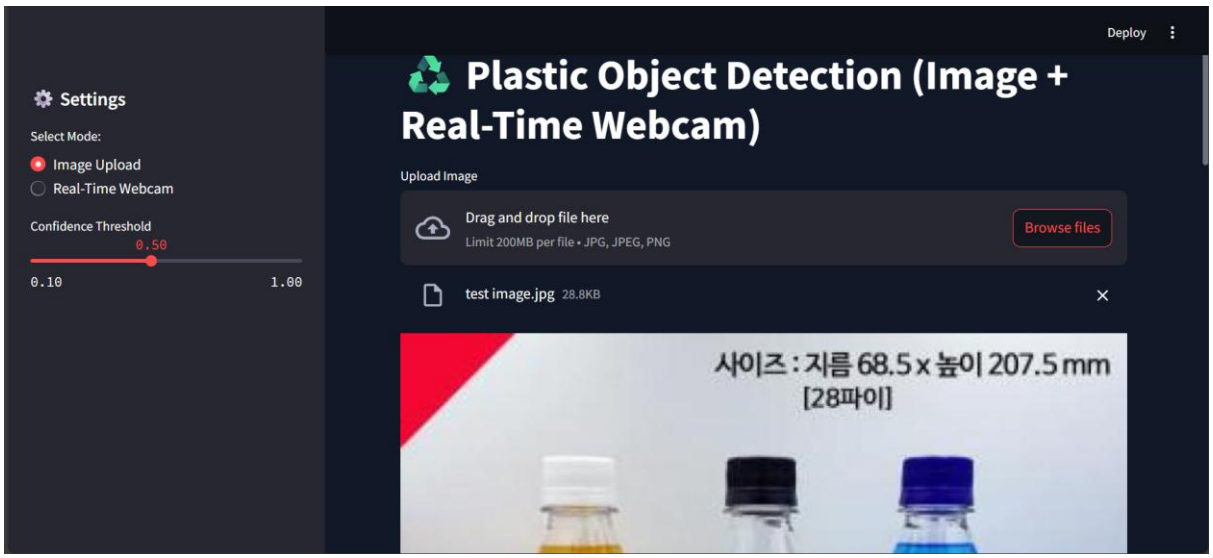
6. Application Screenshots (To be inserted)

Below four screenshots will be added here once provided:

6.1 Main User Interface

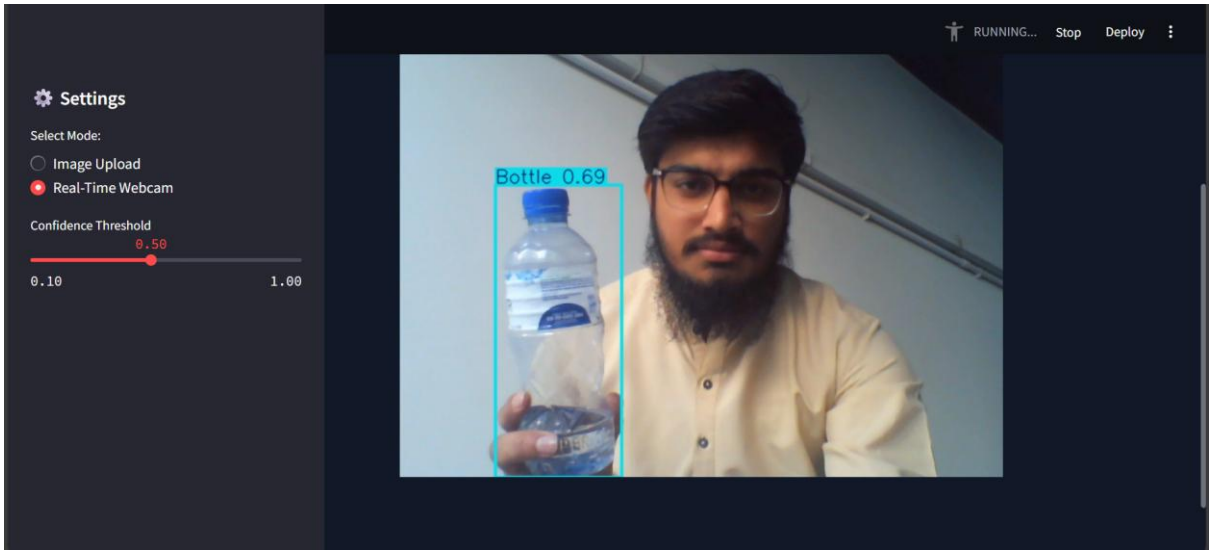


6.2 Detection through Uploaded Image



6.3 Output After Image Detection

6.4 Real-Time Webcam Detection



7. Results & Accuracy

- YOLOv11 successfully detects multiple plastic items
- Real-time detection runs smoothly without GPU
- Image upload gives accurate bounding boxes
- Streamlit UI makes the project professional and easy to use

8. Conclusion

This project demonstrates how modern AI and computer vision techniques can help in waste classification and environmental protection. The combination of:

- **YOLOv11** (for detection)
- **Streamlit** (for deployment)
- **OpenCV** (for real-time processing)

makes this a complete and production-ready solution.

The report, UI, and detection system together create a project that is both technically strong and visually impressive.

9. Future Improvements

- Deploy on cloud for online access
- Add more classes of waste items
- Implement voice alerts for detected objects
- Add object tracking
- Build a mobile version of the model

10. References

- YOLO Official Documentation
- Kaggle Plastic Objects Dataset
- Streamlit Developer Docs

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