PennState College of Education | CSATS Center for Science and the Schools

Research Experiences for Teachers and Young Scholars in Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST)

Developing a Mobile Application to Detect Recyclable Plastics in Real-Time

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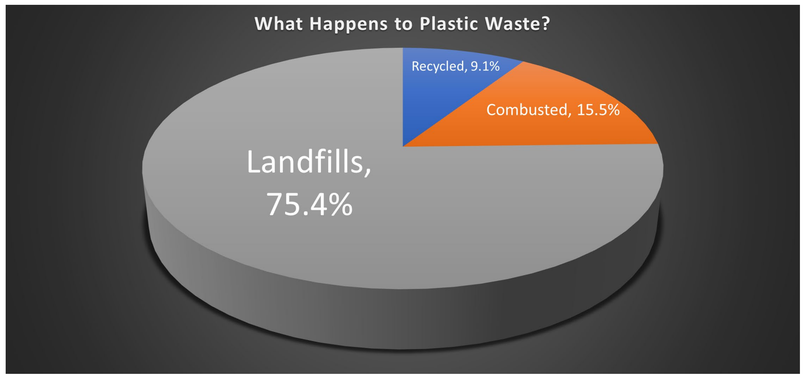
Objective

To create a mobile application capable of detecting plastic materials present in a live video stream.

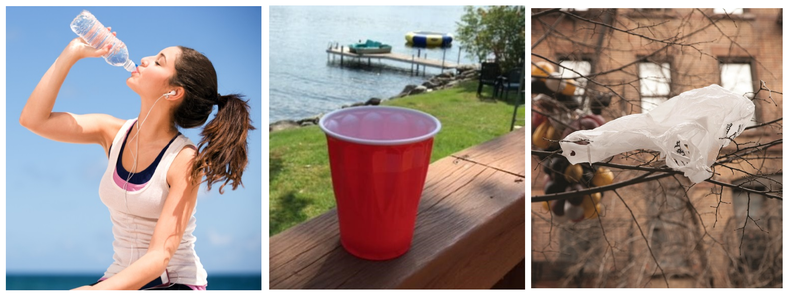
Rationale



According to the EPA, less than 10 percent of plastic waste is recycled while more than 75 percent reaches landfills. Several mobile applications provide information about recyclable plastics and plastic recycling centers, but none offer the ability to identify recyclable plastic in real-time using the mobile device's camera. We set out to develop an object detection model capable of detecting and classifying three types of recyclable plastic materials on a mobile phone as a proof of concept that this functionality could be integrated into an existing mobile application.

Making the Model

Our model was created using the TensorFlow machine learning library. We utilized the MobileNetV2 computer vision neural network and the Single Shot MultiBox Detector (SSD) Lite algorithm. We trained the model to detect and classify plastic bottles, plastic cups, and plastic bags. We obtained a total of 1500 existing internet images of plastic objects from the three classification classes in a wide variety of contexts to train and test our model.

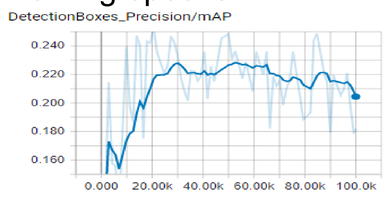


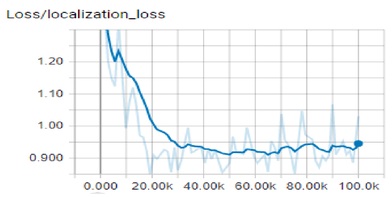
Each of the 1500 images was manually annotated with a bounding box and classification label using the LabelImg tool. The model was trained in 100,000 iterations using 70 percent of the images, with the other 30 percent reserved for testing.

Once the model was trained, we converted it for use on an Android mobile device using TensorFlow Lite, which allowed us to detect and classify plastics in real-time using the live video stream from the Android device's integrated camera.

Results

The model generally showed increased precision detecting objects and applying the bounding boxes with lower localization loss over the course of the 100,000 training epochs.

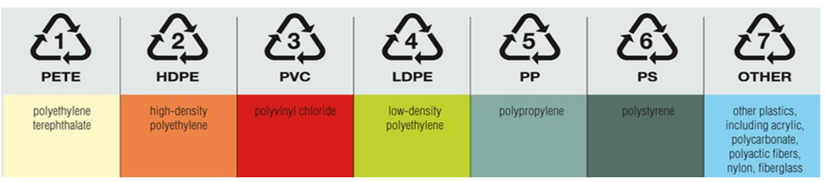




With this relatively small training set, the classification loss somewhat increased throughout the training iterations. The mobile application occasionally labels non-plastics as a plastic item, but the application performs at an acceptable level for an initial prototype.

Implications

Our functional application shows that it is possible for a mobile phone to detect and classify plastics in real-time. With a sufficiently large training set, the model could be improved and adapted into an Application Programming Interface to be made available for use with recycling apps or integrated into a residential waste or recycling sorting facility to detect and sort plastics in real-time.



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