IDENTIFYING RECYCLABLE MATERIALS AT THE SOURCE

Computer vision and artificial intelligence can help consumers sort recyclables more efficiently

The problem is familiar to anyone who has confronted a U.S. recycling bin: Which plastics make the cut? In communities across the country, confusion reigns over which types of plastics are accepted for curbside recycling, which need to be dropped off, and which cannot be recycled at all. Hoping for the best, consumers tend to throw plastic into recycling bins indiscriminately. But "wish cycling," as it is known, does nothing but contaminate waste streams and raise costs. Compared with other types of material, such as aluminum, plastics recycling rates remain below 10 percent. Similarly, most of the electronic waste, or e-waste, ends up in landfills.

People have no simple way to find out what materials are accepted at a given recycling site, a challenge made tougher by the sheer variety of receptacles available, such as curbside carts and bins, public trash cans, dumpsters, open-top containers, waste and recycling chutes in multifamily buildings, and other collection mechanisms.

Efforts to educate consumers on recycling rules include feet-on-the-street inspections and tagging, rejections of contaminated bins, issuing direct mailers and bill inserts, information stations at community events, advertising, and digital media outreach. But these methods are costly, tend to lose momentum, and target a limited segment of the overall population.

A project led by the University of Miami (UM), in partnership with the education company Lid Vizion (LV), developed an application programming interface (API) that can help address recycling confusion. The project included the creation of a new dataset for recycling materials called UM-LV Recycling. The API can immediately recognize different recyclable objects in images and send proper responses based on the consumer's location information. When used to develop smartphone apps or web applications to help consumers scan waste and identify how to dispose of it, the API could help provide clarity and reduce contamination in secondary waste streams.

PROJECT DESCRIPTION

The project team built a computer vision model that can classify waste based on the category (battery, calculator, gamepad, remote, HDPE translucent, and PET clear), achieving an average accuracy rate of over 70%. As part of the project, the researchers built a database of materials and recycling laws based on Miami-Dade County and the University of Miami's recycling program. A demo web application successfully deployed the computer vision model via the API and made inferences on live images, regardless of device.

The team first created the dataset by collecting and labeling nearly 3,000 images of recycling materials. They then used techniques such as image rotation, flipping, noise addition, and cropping to augment the dataset to more than 10,000 images. Using the

dataset, they trained, tested, and tuned an image classification model. Finally, they developed a functional web application that effectively classifies materials as recyclable.

PROJECT IMPACT

If implemented in Miami-Dade County, this solution could avoid 22,765 metric tons of carbon dioxide emissions annually. A national implementation could save 4.5 million metric tons of carbon dioxide, assuming the tool could increase recycling participation by 15 percent. By preventing the need to manufacture new materials, recycling about 3.5 million metric tons of plastics, paper, metals, and e-waste nationally would enable an estimated embodied energy savings of about 85 petajoules.

NEXT STEPS

The team plans to test additional open-source image classification models to confirm gaps in recognition areas and fill them with a custom dataset while working with stakeholders to deploy the technology at the pilot and production stages.

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PUBLICATIONS

Sarafraz, A., Wilborne, S., and Giggetts, L. Identification of Mixed Plastics and Valuable Electronics at the Source: Final Report for REMADE Project: 20-01-RR-4042. December 2023.

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