CLAIMS

1. A method performed by one or more computers, the method comprising:

obtaining, by the one or more computers, image data that indicates an extent to which objects in a recycling-line feedstock reflect, scatter, or absorb light at each of multiple wavelength bands, wherein the image data was collected while a conveyor belt was moving the objects; wherein the image data includes, for each position of a set of positions along a dimension of the conveyor belt and for each frequency of a set of frequencies, a value identifying a reflectance, absorption, or absorbance corresponding to the position and frequency;

preprocessing the image data to generate preprocessed image data, wherein the preprocessing includes performing an analysis across the set of frequencies and the dimension of the conveyor belt;

based at least in part on the preprocessed image data, identifying a subset of the set of positions as corresponding to a particular object of the objects using a segmentation technique, wherein another subset of the set of positions corresponds to another object of the objects;

generating, by the one or more computers, a set of feature values derived from a portion of the image data corresponding to the subset of the set of positions;

generating, by the one or more computers and based on an output produced by a machine learning model in response to the set of feature values being provided as input to the machine learning model, a prediction of an identity or level of a particular chemical in the particular object of a plurality of chemicals in the objects; and

providing, by the one or more computers, data indicating the prediction of the identity or level of the particular chemical in the particular object.

2. The method of claim 1, wherein the preprocessing the image data includes:

normalizing hyperspectral image data using one or more reference image data sets.

3. The method of claim 1, wherein the preprocessing the image data includes:

generating a derivative using the image data;

identifying a threshold; and

performing a threshold-crossing analysis using the derivative of the image data and the threshold.

4. The method of claim 1, wherein the image was collected by a camera with:

a lens positioned such that an optical axis of the lens is between 40-50 degrees relative to a surface of the conveyor belt; or

an image sensor positioned such that an optical axis of the image sensor is between 40-50 degrees relative to a surface of the conveyor belt.

5. The method of claim 1, wherein the image was collected by a camera with:

a lens positioned such that an optical axis of the lens is between 85-95 degrees relative to a surface of the conveyor belt; or

an image sensor positioned such that an optical axis of the image sensor is between 85-95 degrees relative to a surface of the conveyor belt.

6. The method of claim 1, wherein the image was collected by a camera with:

a lens positioned such that an optical axis of the lens is less than 15 degrees relative to a surface of the conveyor belt; or

an image sensor positioned such that an optical axis of the image sensor is less than 15 degrees relative to a surface of the conveyor belt.

7. The method of claim 1, wherein the generating the set of feature values comprises:

accessing a set of kernels; and

convolving each of one or more parts of the preprocessed image data using one or more kernels of the set of kernels.

8. The method of claim 7, wherein at least one of the set of kernels includes a frequency signature corresponding to at least the particular chemical.

9. The method of claim 1, wherein the image data includes hyperspectral image data.

10. The method of claim 1, comprising sorting plastic objects from a waste stream based on predicted identities or levels of chemicals in the plastic objects.

11. The method of claim 1, wherein the machine learning model is a decision tree or a neural network.

12. The method of claim 1, wherein the preprocessing the image data is performed in a same computational workflow as the machine learning.

13. The method of claim 1, wherein the prediction is of an identity of a major component in the particular object.

14. A system comprising:

one or more computers; and

one or more computer-readable media storing instructions that are operable, when executed by the one or more computers, to cause the system to perform operations comprising:

obtaining image data that indicates an extent to which objects reflect, scatter, or absorb light at each of multiple wavelength bands, wherein the image data was collected while a conveyor belt was moving the objects; wherein the image data includes, for each position of a set of positions along a dimension of the conveyor belt and for each frequency of a set of frequencies, a value identifying a reflectance, absorption, or absorbance corresponding to the position and frequency;

preprocessing the image data to generate preprocessed image data, wherein the preprocessing includes performing an analysis across the set of frequencies and the dimension of the conveyor belt;

based at least in part on the preprocessed image data, identifying a subset of the set of positions as corresponding to a particular object of the objects using a segmentation technique, wherein another subset of the set of positions corresponds to another object of the objects;

generating a set of feature values derived from a portion of the image data corresponding to the subset of the set of positions;

generating, based on an output produced by a machine learning model in response to the set of feature values being provided as input to the machine learning model, a prediction of an identity or level of a particular chemical in the particular object of a plurality of chemicals in the objects; and

providing data indicating the prediction of the identity or level of the particular chemical in the particular object.

15. The system of claim 14, wherein the preprocessing the image data includes:

generating a derivative using the image data;

identifying a threshold; and

performing a threshold-crossing analysis using the derivative of the image data and the threshold.

16. The system of claim 14, wherein the image was collected by a camera with:

a lens positioned such that an optical axis of the lens is between 40-50 degrees relative to a surface of the conveyor belt; or

an image sensor positioned such that an optical axis of the image sensor is between 40-50 degrees relative to a surface of the conveyor belt.

17. The system of claim 14, wherein the image was collected by a camera with:

a lens positioned such that an optical axis of the lens is between 85-95 degrees relative to a surface of the conveyor belt; or

an image sensor positioned such that an optical axis of the image sensor is between 85-95 degrees relative to a surface of the conveyor belt.

18. One or more non-transitory computer-readable media storing instructions that are operable, when executed by the one or more computers, to cause the system to perform operations comprising:

obtaining image data that indicates an extent to which ~~one or more~~ objects reflect, scatter, or absorb light at each of multiple wavelength bands, wherein the image data was collected while a conveyor belt was moving the objects; wherein the image data includes, for each position of a set of positions along a dimension of the conveyor belt and for each frequency of a set of frequencies, a value identifying a reflectance, absorption, or absorbance corresponding to the position and frequency;

preprocessing the image data to generate preprocessed image data, wherein the preprocessing includes performing an analysis across the set of frequencies and the dimension of the conveyor belt;

based at least in part on the preprocessed image data, identifying a subset of the set of positions as corresponding to a particular object of the objects using a segmentation technique, wherein another subset of the set of positions corresponds to another object of the objects;

generating a set of feature values derived from a portion of the image data corresponding to the subset of the set of positions;

generating, based on an output produced by a machine learning model in response to the set of feature values being provided as input to the machine learning model, a prediction of an identity or level of a particular chemical in the particular object of a plurality of chemicals in the objects; and

providing data indicating the prediction of the identity or level of the particular chemical in the particular object.

19. The system of claim 14, wherein the generating the set of feature values comprises:

accessing a set of kernels; and

convolving each of one or more parts of the preprocessed image data using one or more kernels of the set of kernels;

wherein at least one of the set of kernels includes a frequency signature corresponding to at least the particular chemical.

20. The one or more non-transitory computer-readable media of claim 18, wherein the generating the set of feature values comprises:

accessing a set of kernels; and

convolving each of one or more parts of the preprocessed image data using one or more kernels of the set of kernels;

wherein at least one of the set of kernels includes a frequency signature corresponding to at least the particular chemical.