Case study on electronic waste

The global generation of waste electrical and electronic equipment (WEEE), or e-waste, is estimated to be 30–50 million tons per year. Although WEEE has a high recycling value, many WEEE items also contain hazardous substances that must be separated from the municipal waste stream. Waste collection companies rely on the involvement of society to properly dispose of e-waste. Different collection methods have been offered, which include collection at supermarkets and electrical and electronic equipment stores, and municipal collection centers. Other methods include mobile collection, such as curbside collection and on-demand collection, where resident can request that the material be collected from a household. On-demand collection may be suitable for efficiently planned waste collection, especially in city centers.

Beyond the collection of the e-waste, there is also a need to sort e-waste into categories for easier handling in later processes. Machinew, an AI company founded in Singapore, is considering building a robotic sorting system for small appliances. The system will use an artificial intelligence to identify objects on a conveyor belt. The AI will identify the brand of the appliances, the type of the electrical appliances, and the recycling value of the electrical appliances (See Table 1 for more detail).

Table 1

Brand	Type	Value
Cornell	Kettle	Low
Electrolux	Vacuum cleaner	Mid
Eurospace	Microwave oven	High
Hitachi	Rice cooker	
LG	Air Fryer	
Mayer	Food steamer	
Midea	Toaster	
Panasonic	Pressure cooker	
Samsung	Coffee machines	
Sharp	Irons	
Philips	Sewing machines	
Tefal	Sandwich maker	
Mistral	Blender	
Rowenta	Juicer	
Braun	Mixer	
Iona	Slow cooker	
Sona	Hair dryer	
Bosch		

After the identification, a series of robotics arms will pick the object and place it into the correct bin. There will be a separate bin for each brand-type-value combination.

The company believes the system is much more efficient compared to human workers. In general, manual picking usually involves 15 picks per minute, however, this sorting robot should be able to perform up to 70 picks every minute. This will significantly reduce operating costs and improve overall productivity.

In this exciting venture, you are assigned to a team that builds the AI that identifies the brand, the type and the value of the appliances on a conveyor belt. The entire team is reported to an AI product owner, who has requested the team to first build a lean deep learning model. So far the team has managed to collect 5000 images, but the spread is uneven: some categories have much fewer images. The images come in various resolutions, but none of them are smaller than 256 x 256. You were told more images would come, and based on the collected images, one of your teammates has built the below model:

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Layer (type)                 Output Shape              Param #
=================================================================
input_2 (InputLayer)         [(None, 128, 128, 3)]     0
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conv2d_3 (Conv2D)            (None, 126, 126, 16)      448
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max_pooling2d_3 (MaxPooling2 (None, 63, 63, 16)        0
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conv2d_4 (Conv2D)            (None, 61, 61, 32)        4640
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max_pooling2d_4 (MaxPooling2 (None, 30, 30, 32)        0
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 28, 28, 48)        13872
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max_pooling2d_5 (MaxPooling2 (None, 14, 14, 48)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 9408)              0
_________________________________________________________________
dense_3 (Dense)              (None, 256)               2408704
_________________________________________________________________
dense_4 (Dense)              (None, 128)               32896
_________________________________________________________________
dense_5 (Dense)              (None, 918)               118422
=================================================================
Total params: 2,578,982
Trainable params: 2,578,982
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a. After looking at the model structure and the training outcome, the AI product owner was not satisfied with the proposed model. She found that the last few layers of the model are not well designed. (i) Do you agree with the assessment? State your reason(s). (ii) Propose a better model to address her concern. (iii) Explain the reason(s) and the advantage(s) behind the changes. (iv) Specify the change in the number of parameters with your new model, the activation function(s) you will use for the classifier part of the model and the loss function(s). Use table and/or figure to illustrate your idea.