Automatic Image Segmentation to Preprocess Pediatric Stool Photos

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Objectives

Collecting unstructured data in the form of image capture from patients in a clinical trial can be a useful mechanism to improve the quality of patient reported data. However, there are practical challenges that can be associated with the collection of patient images such as resolution/quality, sizing and potential PHI acquisition. In an effort to develop mechanisms for ingesting and cleaning such data quickly and effectively, we developed image segmentation algorithms on caregiver-provided pediatric stool photos—extracting only the pixels of stool from a photo and thereby omitting PHI, body parts, and the background.

Methods

We collected 720 images of diaper stool from freely accessible online sources, and an additional 212 infant and toddler stool photos from an internal study with parents (n=9). After manually segmenting all 932 photos, we created training and test sets of ~80/20% respectively.

Results

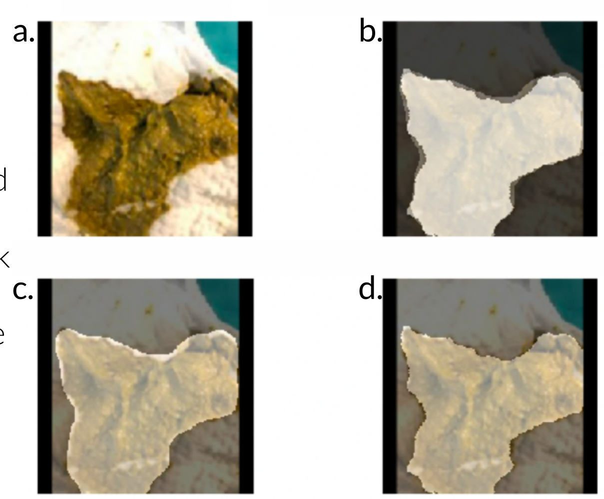

Figure 1. Sample input image (a) from the labeled test set, with with manu-ally-annotated trush mask in (d). The algorithm predicts ((c). We illustrate the close overlap in (b).

	Model	Train/Test; data source	Training Epoch	Mean IoU
A	Baseline SegNet from Cornell Paper	80-20; online:sprim	110	47%
C	Baseline SegNet from Cornell Paper	80-20 mixed online and sprim	167/9	33%
D	Model with Gaussian Blur and No Weight Decay	80-20 online:sprim	100	71.20%
E	Model with Gaussian Blur and No Weight Decay	80-20 mixed online and sprim	199	82.60%

Table 1. Stool segmentation performance across varying training-set, test-set combinations and varying preprocessing tecniques.

For our use case with pediatric stool, we replicated the model architecture from a literature paper performed on adult stool in a toilet (Hachuel et al. 2019), and then performed a variety of hyperparameter experiments, recording the Mean Intersection over Union score for each model (IoU). Image augmentation resulted in 9050 total images (with 1810 reserved for a test set). When training the model architecture on the non data augmented dataset, we achieved an IoU score of 47%. When trained on the data augmented dataset, we achieved a Mean IoU score of 33%. This is significantly lower than the adult stool application in Hachuel et al. To create a new, improved model more suited for the pediatric use case, we modified the network with Gaussian blurring as a pre-processing step and eliminated weight decay. With our new model, we achieved a mean IoU score of 71.2% on the non data augmented dataset, and with the augmented dataset we achieved a mean IoU of 82.6%. Therefore, our new model performs as well as the state of the art in Hachuel et al. on the new use case of pediatric stool on a diaper background.

Conclusions

Parents are asked to recall characteristics of stool consistency, record a diary, or take photos of stool in the diaper to assist their pediatric gastroenterologist in making an accurate diagnosis of their child. We provide evidence that image segmentation is a viable method for segmenting stool from the pictures collected by caregivers. This ultimately creates an important preprocessing step before providing photos to central raters of a clinical study, or in organizing a monthly stool report for a clinician. Furthermore, this work provides a foundation for training new algorithms for analyzing stool consistency or color in a context without bias from the diaper or background.

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