Depth video data enabled prediction of dairy cow body weight

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INTRODUCTION

Obtaining accurate estimates of cow body weight is critical in farm managements because they are associated with the growth, nutritional status, and health of cows. However, it requires human labor or expensive equipment to collect body weight records.

OBJECTIVE

The objective of this study was to predict cow body weight from 3D video data using computer vision and deep-learning techniques.

MATERIALS AND METHODS

Data Collection

We set up an Intel Realsense D415 camera at the Virginia Tech Kentland farm to collect top-view videos for 10 Holstein and 2 Jersey cows for 28 days, twice per day. Real body weight records were also obtained by the Afimilk system simultaneously. A total of 40,405 depth images and depth CSV files were obtained.

We explored three approaches to segment the cow body from the background, including single thresholding, adaptive thresholding, and Mask R-CNN. Four image descriptors, length, width, height, and volume, were estimated from segmented images and then fitted in ordinary least squares (OLS) and random forests (RF).

Real body weight at different timepoints

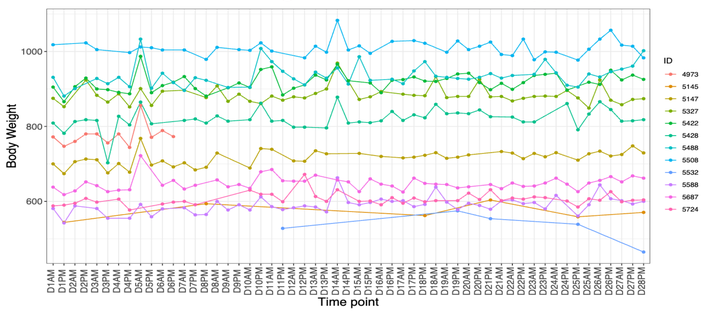
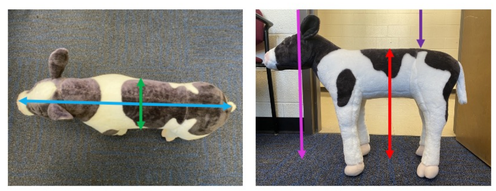
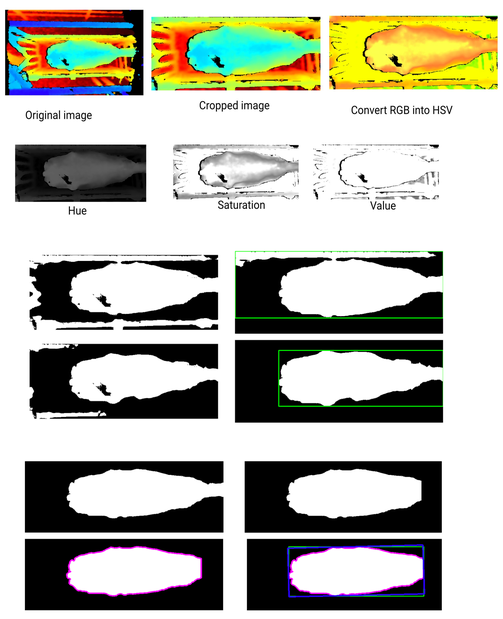


Image descriptors

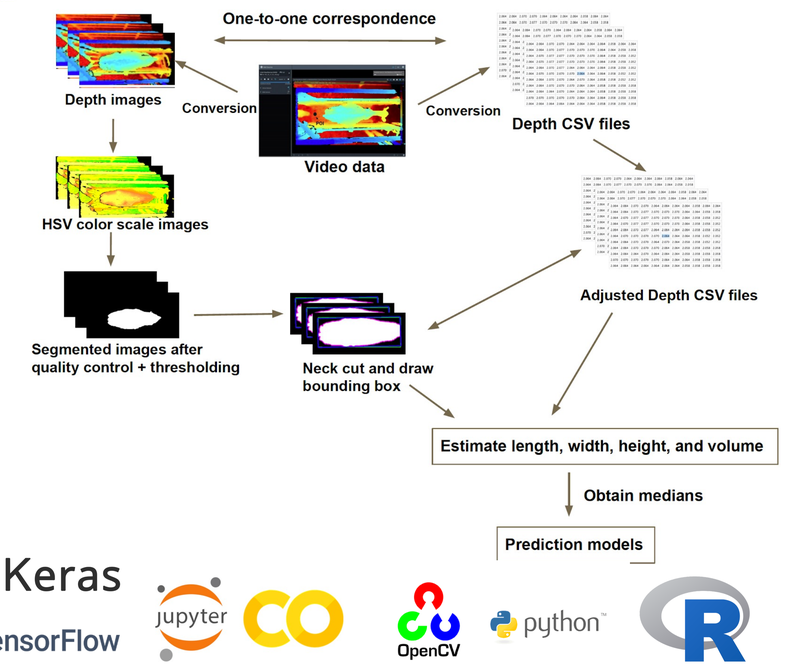


length, width, height, volume

Thresholding Approaches

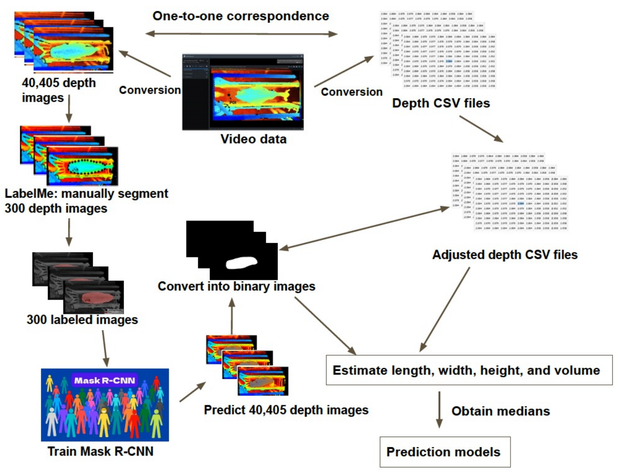


Flowchart for Thresholding Approaches

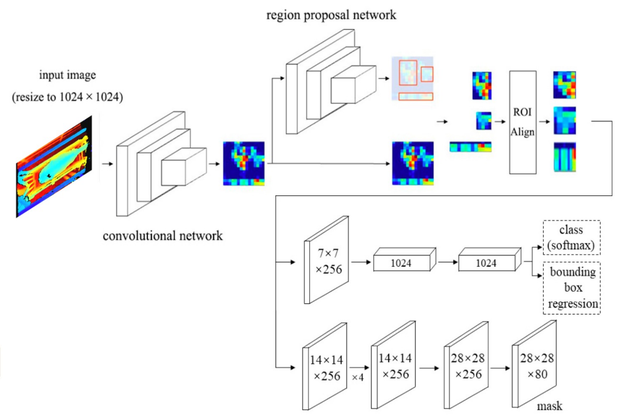


Mask R-CNN

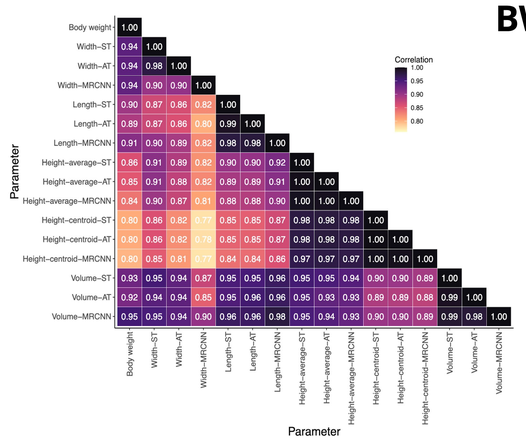
Flowchart for the Mask R-CNN approach



Mask R-CNN Architecture



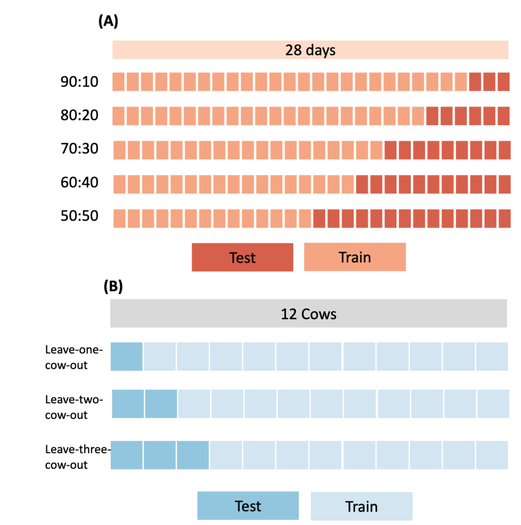
RESULTS

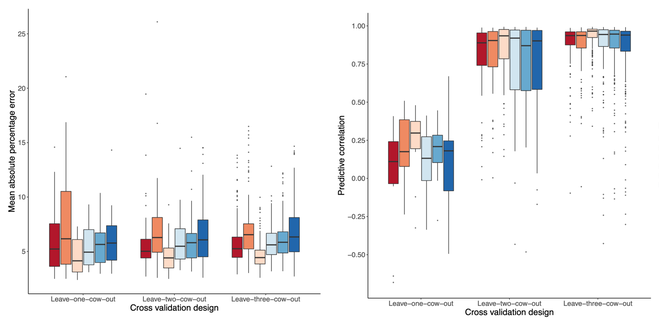


BW = Length + Width + Height + Volume

Table 1: Prediction results for cross validation 1 (forecasting)

Method	CV[1]	r^2		MAPE (%)[3]	
		OLS[4]	RF[5]	OLS	RF
Single Threshold	CV90	0.97	0.98	3.90	3.18
	CV80	0.96	0.98	4.29	2.92
	CV70	0.96	0.98	4.44	2.64
	CV60	0.96	0.98	4.48	2.57
	CV50	0.96	0.98	4.47	2.59
Adaptive threshold	CV90	0.96	0.98	4.66	2.86
	CV80	0.95	0.99	5.30	2.46
	CV70	0.95	0.99	5.42	2.30
	CV60	0.95	0.99	5.29	2.28
	CV50	0.95	0.99	5.18	2.44
MRCNN	CV90	0.98	0.98	3.42	2.95
	CV80	0.98	0.98	3.48	2.65
	CV70	0.98	0.98	3.55	2.76
	CV60	0.98	0.98	3.59	2.78
	CV50	0.98	0.98	3.67	2.96





CONCLUSIONS

Our results suggest predicting cow body weight from depth video data is feasible (~3% MAPE).

ACKNOWLEDGMENTS

- VT Pratt Animal Nutrition
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