Tracking Red Blood Cells in Real Time with Deep Learning

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The long-term goal is to develop an automated, real time, in situ red blood cell (RBC) identification, counting, and RBC distribution width (RDW) calculating system using deep learning. The aim of this work was to develop the deep learning model that can identify red blood cells. 200 images containing RBCs were annotated using Microsoft's Visual Object Tagging Tool. Using the You Only Look Once object detection public repository and Tensorflow 1.14.0, a deep learning model was created to identify RBCs and create a bounding box around the RBC to signify that it has been recognized. The 200 images were used for training. The model correctly identified 6.51±3.14 RBCs in test images as compared to 7.44±3.58 that a human was able to identify ($p<0.01$). The model identified RBCs well, though not statistically as well as a human being. The model also assigned a score for each bounding box with an average score of 60.6%±9.7%. This score represents the confidence the model had with each cell it identified. These scores were low because the quality of the images was poor. With more training with hundreds of more images, this model was able to identify 94%±3% of the RBCs in images at 1500x magnification. The model performed significantly poorly ($p<0.05$) in lower magnification images of 1000x and 600x (32% ±10% and 7%±0.4%, respectively) because the model was trained on high magnification images. This model also identified RBCs on videos and tracked the movement of the RBCs well. However, it also inaccurately identified areas of the video that were not RBCs. With more training, this model shows promise in identifying and tracking RBCs. This model will then be programmed to measure the RBC diameter and calculate RDW.

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