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Research Abstracts

Towards Automated Assessment: Evaluating Phase Segmentation Accuracy of an AI Model in Advanced Training for Laparoscopic Suturing (ATLAS) Simulator

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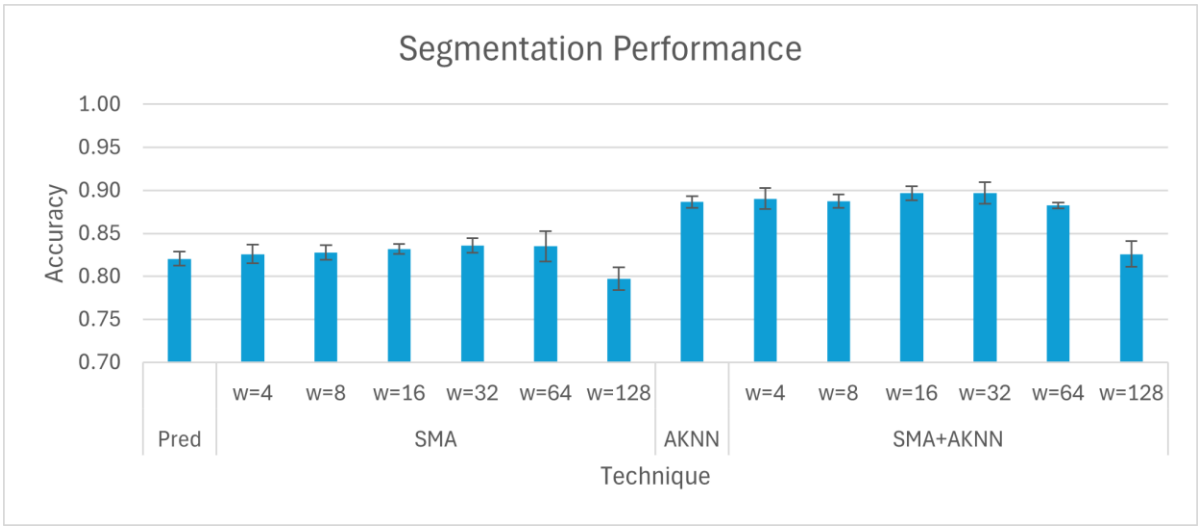
Introduction: The Advanced Training in Laparoscopic Suturing (ATLAS) curriculum was developed to improve laparoscopic skills via a proficiency-based approach through six distinct tasks. Task 1 involves passing a needle through six holes positioned at various angles on a circular platform. Performance is assessed based on the task completion time and the number of errors. The goal of this research is to explore the potential of an artificial intelligence (AI) model to precisely segment the phases of the task, which is essential for computing task duration.

Methods: Forty-nine performances of Task 1 completed by medical students, trainees, and faculty were recorded. The videos were annotated to identify the start and end frames of ten distinct phases. An X3D deep convolutional neural network model was trained for phase segmentation. A hybrid post-processing approach combining a smooth moving average (SMA) filter and ATLAS K-Nearest Neighbors (KNN) was employed to enhance segmentation. The Exponential Moving Average (EMA) was also tested for comparison. The activation functions in the X3D model were switched to Hard-Swish to evaluate performance.

Results: Of the 49 videos, 39 were used for training, and 10 for testing. The original model achieved 82.06% accuracy, which improved to 83.58% with SMA. Further improvement yielded 88.65% with AKNN and 89.68% with a hybrid of SMA and AKNN (Fig. 1). EMA and the hybrid of EMA and AKNN results were 82.12% and 89.02%. Switching to Hard-Swish activation in bands A and B resulted in accuracies of 88% and 89.76%, respectively.

Conclusions: The AI model effectively segmented the phases of the ATLAS Needle Handling task. This model could be utilized as a potential tool for evaluation, thereby reducing resources required for assessment. In the future, the model will be extended to assess task duration and errors across all ATLAS tasks.


Segmentation Performance
1.00
0.95
0.90
0.85
0.80
0.75
0.70
Accuracy
w=4
w=8
w=16
w=32
w=64
w=128
w=4
w=8
w=16
w=32
w=64
w=128
Pred
SMA
AKNN
SMA+AKNN
Technique