Automatic assessment of training level using Computer Vision

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Introduction

Video Based Assessment (VBA) is the most popular way to assess technical skills of trainees in minimally invasive surgery but it has major limitations mostly related to its subjectiveness and the large time commitment. In our study, we designed a computer vision AI model capable of automatically assessing the trainee level on a suturing robotic task.

Methods

Twenty-seven surgeons performed a robotic suturing task on a bench-top model. Videos were recorded of participants performing the task of back-handed suturing on a dry lab model. Bounding box annotations were created to identify the surgical instruments in each video by 2 senior surgical residents for 231,069 frames(Figure1). Each participant was ranked based on their post graduate year level of training. ResNet features were extracted from padded instrument bounding boxes in order to focus on visual information alone. An 11-layer 1D convolutional neural network was used to predict the experience level of the surgeon. For training and evaluation, 10 second clips randomly extracted from the middle 60% of the training videos were used.

Results

The average level of training for our participants was 2.74 years with a standard deviation of 2.07. Our model achieved a mean absolute error (MAE) of 1.43 on a 3-fold cross-validation over 27 participants (with 9 in the validation sets per fold). The predictions made by this model, based on a 10-second clip, will be on average off by 1.43 years of training from the actual year of training of the participant.

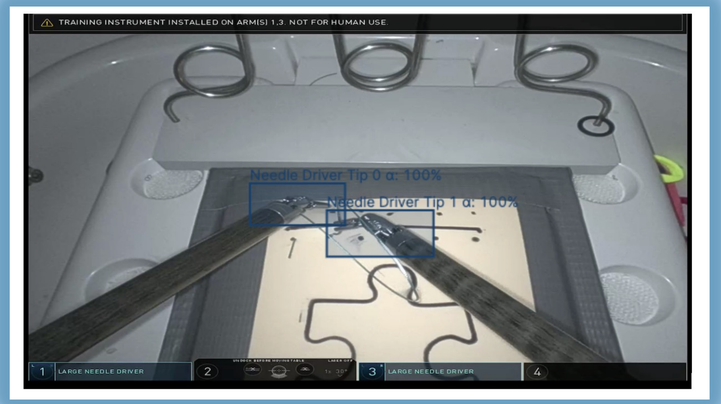


Figure 1 Bounding Box Annotations of 1 Frame

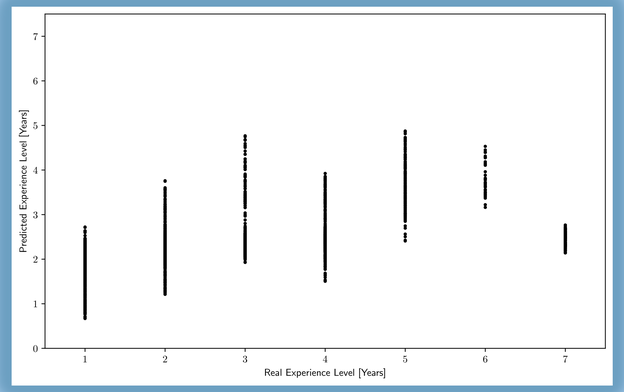


Figure 2 Model predictions vs. ground truth for our proposed model

Conclusions

We were able to successfully train a computer vision algorithm to automatically assess the training level of a surgical trainee from one surgical task to within 1.43 years. This model can be used in the future to design a robotic education curriculum where surgeons in training can see if they are at an adequate point in their technique and work to improve their skills in a dry lab setting.

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