DORC: Dynamic Operating Room Companion for Gallbladder Removal Surgery Workflow Verification

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Every year, 4000 human errors occur in the operating room. Surgical workflow recognition is a burgeoning field of study that aims to combat this problem by analyzing medical video and identifying tool presence and surgical action in each frame. This project uses the Cholec80 dataset, which contains 80 full-length gallbladder removal surgery videos with frame-by-frame annotations. Our goal of live surgical action recognition is split into two tasks: (1) identifying the tools in each frame and (2) analyzing patterns and time-dependencies within tool presence to deduce current phase. (1) For tool identification, I created an algorithm that uses Support Vector Machines to minimize the search space. I attained an 89% tracking accuracy compared to a 90% state-of-the-art, but gained an advantage in runtime of 60ms/frame compared to 300ms/frame. This allows my method to be used on live video with a higher frame count, making it more useful in a real-world hospital scenario. (2) To analyze tool patterns and temporal dependencies, I combined two methods: hidden Markov model (HMM) and linear temporal logic (LTL). LTL is traditionally hard-coded, but to maximize efficacy, I created a program to extract LTL rules from the training dataset. My algorithm successfully mapped between tool presence and phase labels for 93.5% of all frames in the testing dataset, matching state-of-the-art performance achieved by a recurrent neural network for this task. These results indicate that my system and methodology are sound with strong potential to be used for live surgery.

Awards Won:

Second Award of $2,000

NC State College of Engineering: Award to attend NC State Engineering Summer Camp