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Real-time, AI-enabled surgical insights via intraoperative notifications – the next generation of Surgical Intelligence

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Introduction

The automotive industry has long embraced technology, and in years to come, autonomous vehicles will likely be widely available for consumers. Today, consumers expect real-time support in their vehicles. It started with basic features like cruise control, then moved towards driving assistance features such as collision avoidance and blind spot monitoring. These features rely heavily on computer vision capabilities, intending to reduce human errors using pre-defined prompts in the form of notifications that alert the driver's attention while driving.

We suggest that similar concepts can be defined and applied to the surgical domain as part of a Surgical Intelligence Platform, leveraging computer vision to accurately and immediately identify predefined intraoperative moments.

Real-time

Many studies undertaken in recent years aim to explore how to automate the recognition of specific tasks, such as step segmentation, tools and event detection, safety milestone recognition and others. Done at scale, such annotation-based knowledge turns into analytics and insights that support maintaining and disseminating surgical best practices, decreasing variabilities and ultimately improving patient care. Existing works on extracting these insights have focused on pre- and post-operative assistance, shying away from intraoperative workflow aid.

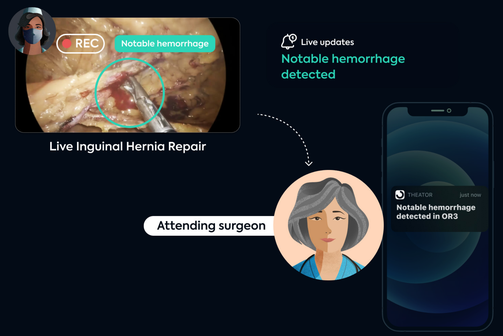
Our approach presents the next generation of Surgical Intelligence by providing, for the first time, real-time push notifications. This is done by developing new AI-based capabilities designed and trained to deliver fast, accurate, and valuable information to the surgeon in real-time.

To date, a significant technological gap, both speed and accuracy, has hindered the use of existing AI annotations in operating rooms in real-time. This work bridges this gap and delivers highly accurate annotations in real-time, i.e., surgical procedures are structured and annotated as they occur, an application that has numerous advantages and implications.

Use case examples

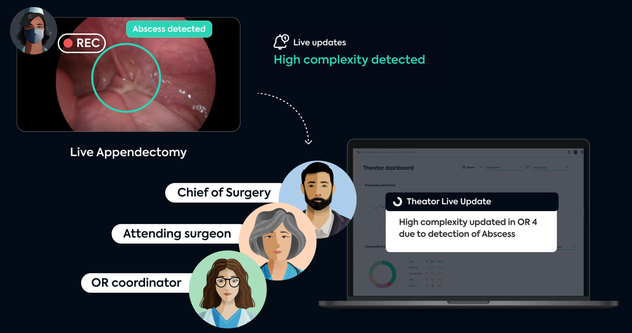
Use case I

Detecting and then notifying in real-time of certain events, such as significant bleeding or misuse of an air leak test to mitigate the risk of colorectal anastomotic leakage.



Use case II

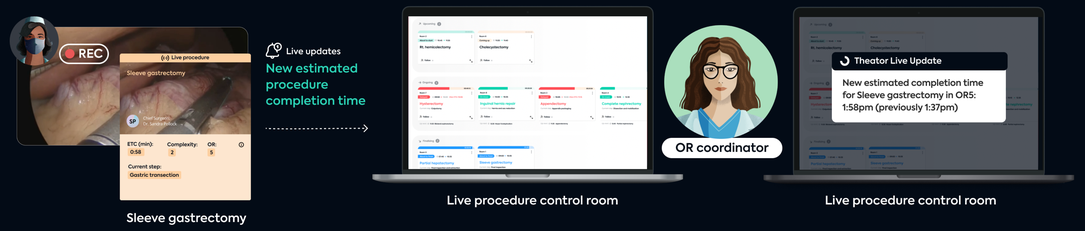
AI can evaluate and compare procedures' complexity levels based on prior conditions, anatomical variables, and disease-related factors and notify in real-time to relevant personnel of an ongoing complex or untypical case.



Use case III

OR scheduling adjustment when surgery is automatically estimated to be prolonged.

This allows clinical and OR staff to optimize scheduling and resource allocation based on the real-time progress of each case.



Summary

Applying AI to surgical-related tasks has numerous applications. Despite the latest advances in Surgical Intelligence technologies, the main limitation is that they all provide offline value, once surgery has ended. The ultimate goal remains the ability to react and interact with the surgeon as surgery is taking place. This requires that predictions be provided with high accuracy and in real-time. This work demonstrates that this concept is already operational and can deliver meaningful insights, today.

Future work will focus on collaborating with surgeons to define and design the best way to incorporate this information into the OR and support the surgeon's decision-making process in real-time.

Real-time notifications are an initial but crucial step towards AI-based, data-driven decision support for surgeons during an ongoing procedure. Similar to the advancements that are taking place in the autonomous car industry, the next few years will prove pivotal in shaping the future of surgery.

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