Building Advanced and Safe Robot-Assisted Surgical Systems that Give Guidance in Real Time

Robotics, intelligence and advanced visualization technologies are driving the next-generation robotic surgical systems. These involve the ability to provide visual intraoperative data along with insights to surgeons, helping them make accurate decisions during surgery. For example, processes still relying on decades-old system of using fluorescent dyes can be replaced with advanced computer vision, AI and ML to help surgeons see vasculature clearly.

With advanced robotics-assisted surgery systems combined with high quality 5G-based end-to-end connectivity that enables low latency, robotics-assisted surgeries are poised to create dramatic positive difference in reducing preventable medical errors. Estimates vary but hundreds of thousands of deaths annually are attributed to such errors in the US alone.

The potential of IoT and AI-enabled and 5G- driven systems is enormous in the field of healthcare. World-class surgeons, for example, could perform surgery from anywhere in the world without having to be physically present in the operating room.

The challenge

Device portability and developing training data for AI and ML-driven processes at the edge for relevant insights

What's needed for greater and faster adoption of autonomous surgical systems are big data, cloud, AI and analytics platforms and edge processing to make these systems portable, accessible, affordable and safe. Portability is important so that devices can be moved from room to room. Affordability is a challenge as these systems tend to be hugely expensive because they are built on powerful but expensive chipsets.

Trained data: As in all AI and ML-based systems, autonomous surgical systemsneed massive amounts of training data so that their algorithms can be perfected over time to offer meaningful insights, depth sensing and 3D rendering and become truly autonomous.

Self-driving cars, for example, need to process trillions of bits visual data to ensure the cars don't cause accidents. Similarly, for telehealth projects and specially for autonomous medical processes, safety is paramount and hence needs trained data. However, video annotation is time consuming and therefore requires effective automation tools.

Client need

Our client, one of the pioneers in AI and computer vision-based surgical systems provides real-time visual data and insights to surgeons—also faced these challenges of creating a portable device with automated video data processing for real-time insights as well as ensuring compliance with FDI requirements.

This innovative company builds products that enable autonomous and collaborative surgery based on computer vision, AI and robotics. The client's platform uses data collected from surgical systems connected to cameras and sensors for real-time data during surgeries. The data is used to develop ML and AI-based visualizations that guide surgeons during surgery to get information that was previously not available in real time. This guidance helps reduce the risk of errors and improves outcomes for patients.

The client's products provide surgeons and surgical systems with augmented visuals and real-time guidance during surgical procedures.

The company wanted a portable device with a compute board that could assimilate high bandwidth videos of two cameras and make inferences with edge ML models. The company needed to transform huge numbers of videos gathered intra-operatively to help characterize tissue and critical structures. Additionally, they needed to ensure not only affordability but future-readiness of their products in an evolving market.

For guiding every surgical task atleast a thousand videos from various sources need to be stored, cleaned, labelled and processed. As manual processing of data would take years, the client decided to work with Innomindsto build an annotation solution. It turned to Innominds to not only create the hardware, build the analytics but also develop the necessary applications.

What we did
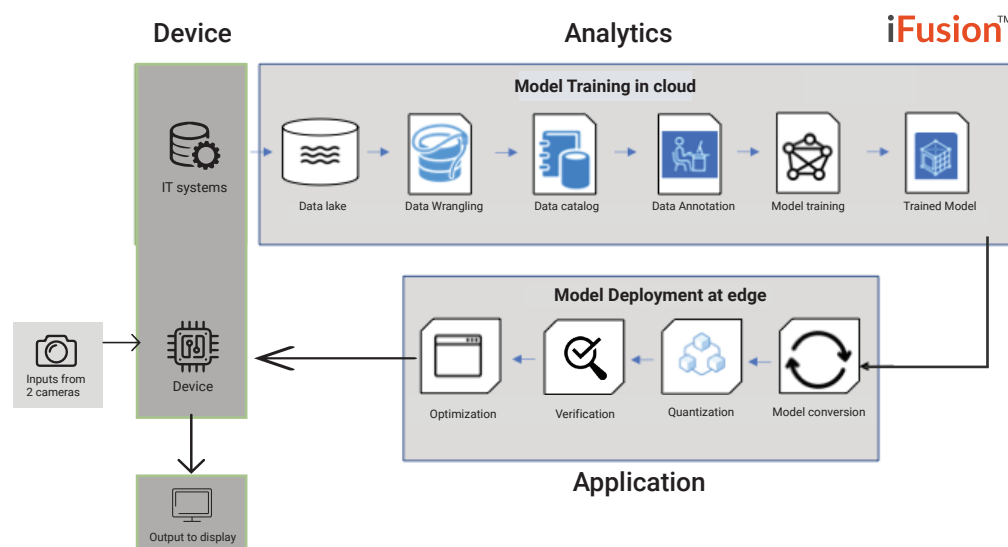
Integrating devices, analytics and apps

Innominds brought to the table its deep expertise across devices, apps and analytics to create a powerful, portable and affordable hardware and an analytics solution.

Device hardware

With the aim of making a future-ready and affordable device, Innominds leveraged its home-grown iDhi platform to re-place the first-generation compute board which was based on an expensive system setup. iDhi is specially built for medical environment with a modular approach of customizable carrier board and SoM built on Qualcomm's QCS8250 chipset, one of the most advanced mobile computing chipsets enabled for 5G connectivity and WiFi 6. Our partnership with Qualcomm is a huge advantage to the client as it means we can provide long-term support.

The solution leverages the chip's powerful heterogenous compute capability with a CPU, GPU, digital signal processor (DSP) and neural processor to accelerate complex medical algorithms. It is designed to receive video feed from two cameras, process the video feed, make inferences in real time with glass-to-glass latencies as low as 150ms and control the laser that is used in surgery. The device is equipped with 5G capabilities such as ultra-short latency of 1ms, extreme high bandwidth, multi connectivity to deliver high mobility, availability, and reliability.

Software

iDhi comes with board support package (BSP) that enables the cameras and other peripherals to connect with the compute board, display annotated video on monitors and control the laser system. The Android system ensures that the updates and security patches can easily be incorporated without the need for re-engineering the device.

The solution enables medical image pre-processing and post-processing with ability to port algorithms using Open CL and Open GL and accelerate them on heterogenous compute system. The solution is designed to integrate with Azure cloud components for IoT device and data management, ARI device management plugins for connecting to the cloud, and SNPE SDK for implementing trained ML models on the platform.

FDA certification

Innominds has trained professionals who understand how to implement FDA guidelines in the design lifecycle of complex medical devices. We have accounted for all the necessary software testing to make the device ready for FDI certifications.

The team has ensured that the solution follows FDA requirements and IEC62000 immunity standards for EMI, EMC, and ESD. They have designed the solution as per FDA guidelines of hardware-based uninterrupted video link between camera and display through watchdog in case of any software malfunction.

iFusion™ analytics platform for model training in the cloud

Developing trained ML models at the edge involves collecting video inputs from various sources (hospital IT systems and field devices) and pre-processing the inputs so that they can be ingested into the video store. The videos are cleaned and anonymized in accordance with mandated data privacy laws. We then use our proprietary analytics platform—iFusion™ – with its inbuilt accelerators to process it further for annotation and create more training data.

We leverage iFusion to do data wrangling, data cataloging, data automation and model training in the cloud before deploying the data models to the device. We manage the data in the Azure cloud.

Video analytics and ML at the edge

The platform's video processing capabilities enables the device to acquire and process video feeds from two high data bandwidth surgical cameras. Subsequently we make inferences on the acquired video feed using trained ML models deployed at the edge. We also developed the tools to control and operate lasers and ported laser speckle algorithm to Android OS on the platform to work on the acquired video feed.

During a medical operation, the images relayed to the surgeon have to be instantaneous. This implies there has to be low latency. Even if there is a delay by a fraction of second it could have adverse consequences on the ability of the surgeon to operate correctly. Such a strict window of extremely low latency requires both a powerful chipset such as the QCS8250 and highly accurate trained data models to be deployed at the edge.

The impact

Real-time intelligence and advanced imaging

10x faster processing: With our expertise, the client has been able to meet its goals of portability, affordability and safety. With our powerful solution the client is able to leverage its algorithms to process surgical videos on 10 TOPS cumulative compute power.

Largest annotated data set: The video annotation solution is also being used to create the industry's largest annotated data which will support other AI and edge ML-based products and platforms the client has in the pipeline.

Contextual data in real time: Our iDhi platform capabilities and our iFusion™ platform accelerators are helping the client push the frontiers of autonomous surgical systems that provide real-time contextual data and insights during surgery with glass-to-glass latencies as low as 150ms.

These systems will enable collaboration between experienced surgeons and surgical systems all over the world, ensuring better access to healthcare anywhere.

What the client says

"Our partnership with Innominds and Qualcomm will ensure surgeons everywhere will have greater access to cutting-edge technology that will enable them make better informed decisions with the use of our real-time overlays and clinical insights which minimize surgical errors."

CTO (Client)

About Innominds

Innominds is an AI-first, platform-led digital transformation and full cycle product engineering services company headquartered in San Jose, CA. Innominds powers the Digital Next initiatives of global enterprises, software product companies, OEMs and ODMs with integrated expertise in devices and embedded engineering, software apps and product engineering, analytics and data engineering, quality engineering, and cloud and devops, security. It works with ISVs to build next-generation products, SaaSify, transform total experience, and add cognitive analytics to applications.