

Opportunities and Challenges of 5G in healthcare: Pillcam for automatic detection in the screening of colon cancer

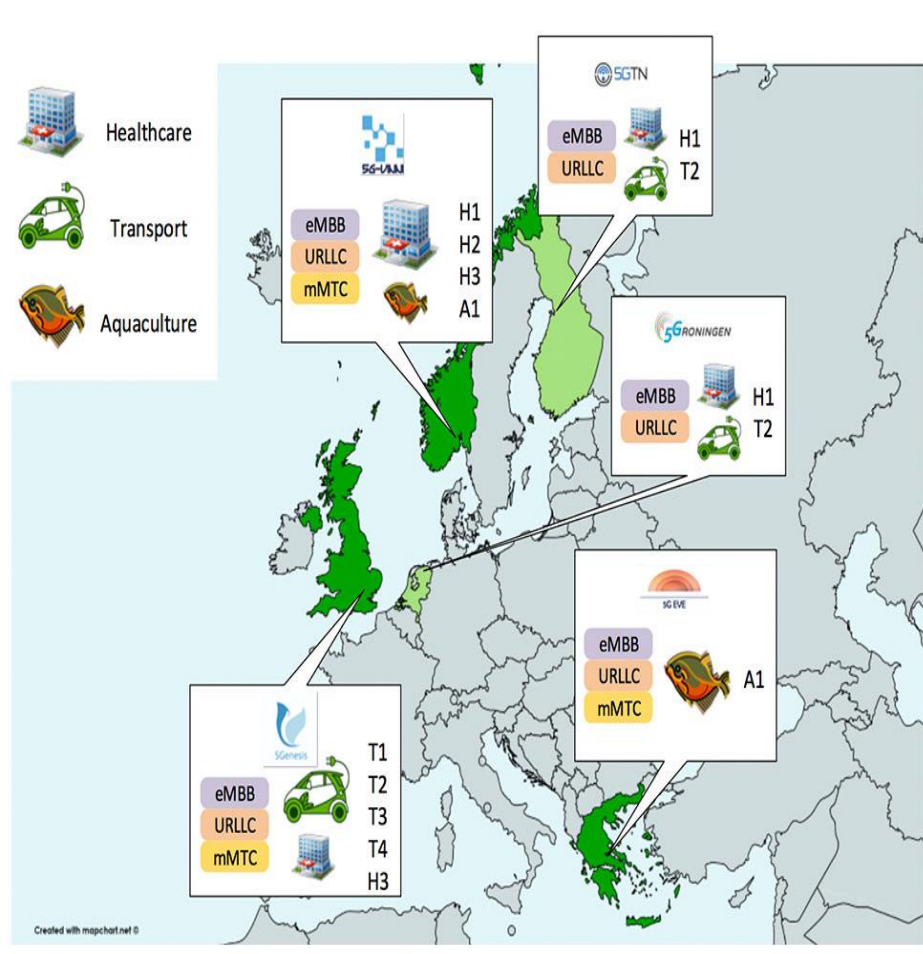
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Healthcare	
Use Cases	Contributors
H1: Remote interventional support eMBB URLLC	SGTIN, SGTIN, 5G GRONINGEN Oslo Oulu Groningen
H2: Pill camera eMBB URLLC	Concurrency Testing Surrey
H3: Vital-sign patches with advanced geolocation mMTC	Telenor, Philips, OUS, RedZinc, VTT, UOS, TNO, CEA

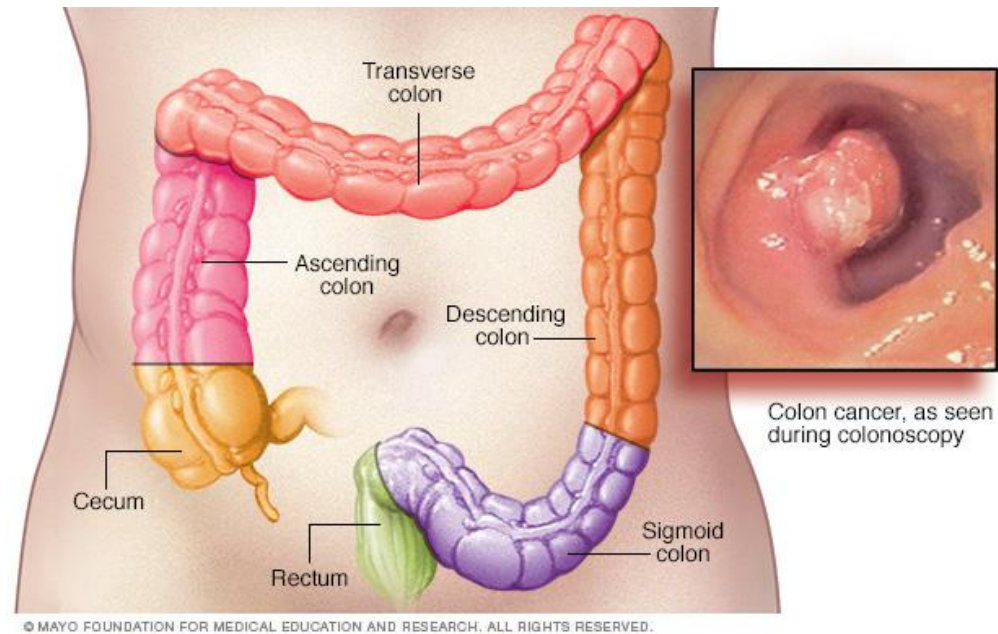
Aquaculture	
Use Cases	Contributors
A1: Remote monitoring of water and fish quality eMBB URLLC mMTC	5G EVE Athens, 5G-VAMM Oslo WINGS, Skironis, Marine Institute, SEALAB, Telenor, OTE, Ericsson, ACTA, Intracom, NTUA

Transport	
Use Cases	Partners
T1: Platooning eMBB URLLC	Surrey, SGTIN, 5G GRONINGEN Oulu Groningen
T2: Autonomous/assisted driving URLLC	Concurrency Testing
T3: Support for remote driving eMBB URLLC	UOS, Dynniq, Epitomical, OCC, Polar, VTT, TNO, NTUA, CEA, TUC
T4: Vehicle data services mMTC	



- H2020:ICT
 - 01.06.2019 – 31.12.2022
 - Budget: 14.5 million € (150 million NOK)
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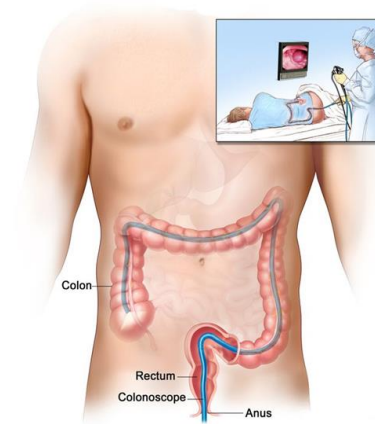
Colon cancer second most common cancer for both genders (15% prevalence above age of 55)



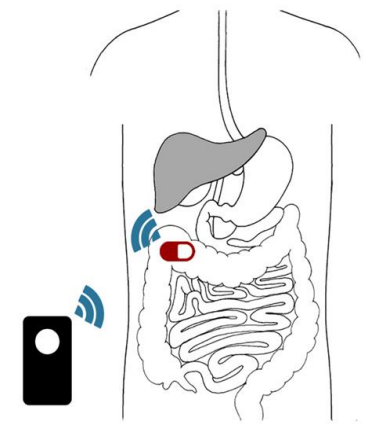
- Early diagnosis means prolong lifetime or lead a normal life
- Early detection and removal of polyps has clear value
- Screening program in Norway from 2023

Mass screening for colon cancer

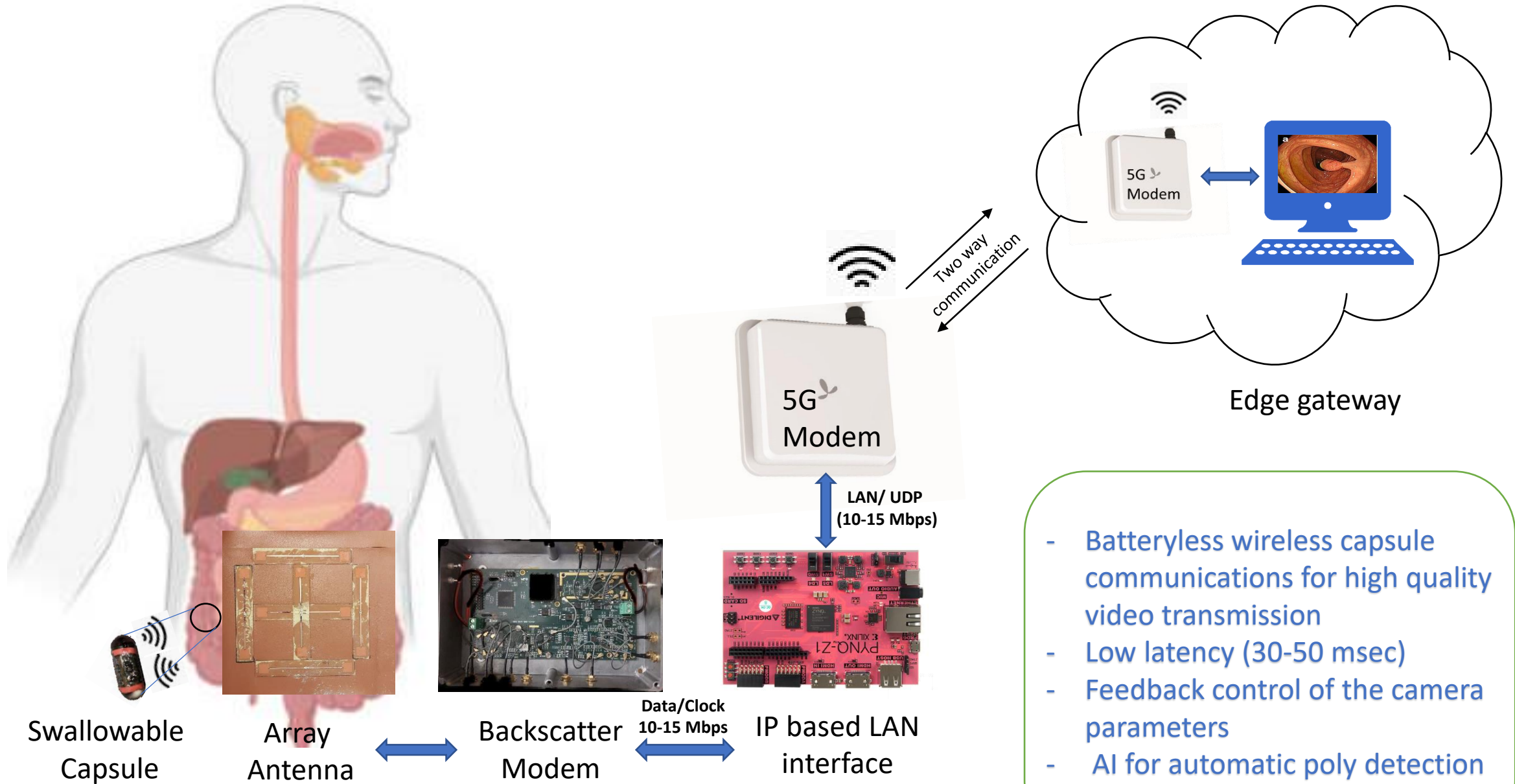
- Colon cancer:
 - **Second most common** cancer mortality for both genders.
 - **Early detection can save lives.**
- **Colonoscopy**
 - Significant time spent by the specialist.
 - Discomfort and risks inherent to the procedure.
- **Wireless capsule endoscopy**
 - User takes a capsule at home. Video transmission using 5G to a cloud. AI algorithms detect polyps and send a report to the user and the GP.



Conventional colonoscopy



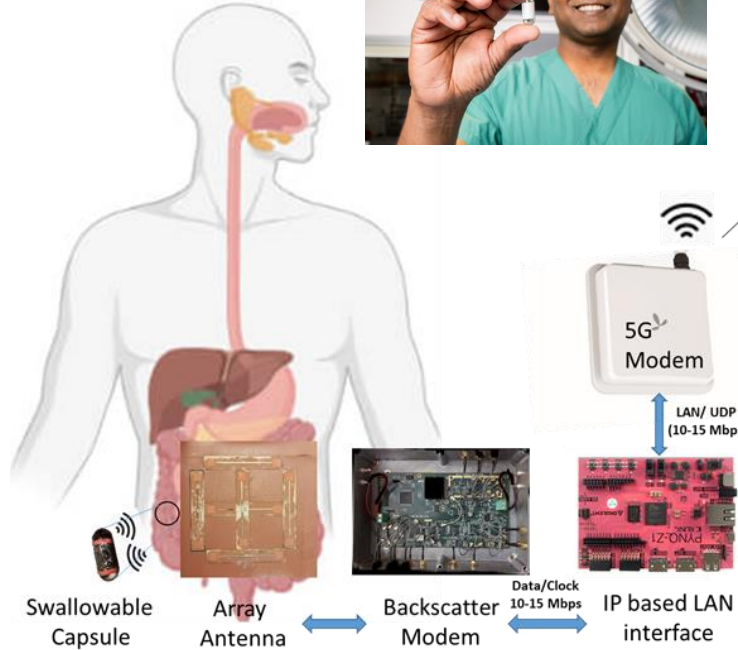
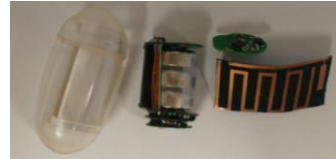
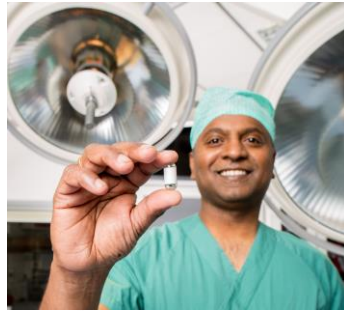
Wireless capsule endoscopy



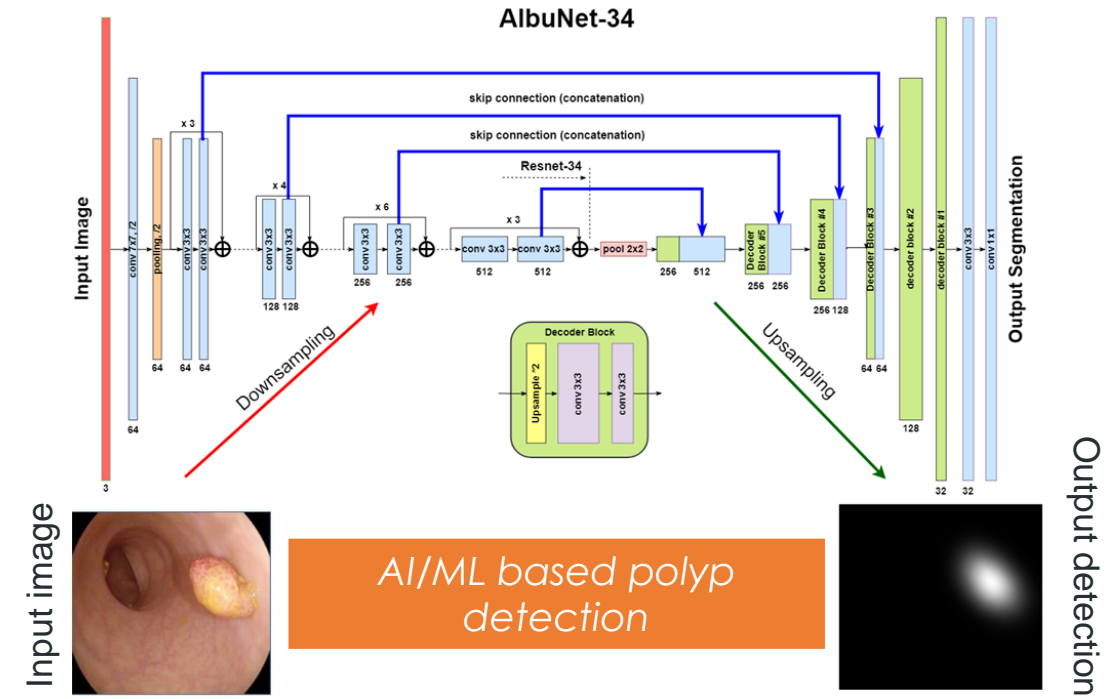
- Batteryless wireless capsule communications for high quality video transmission
- Low latency (30-50 msec)
- Feedback control of the camera parameters
- AI for automatic poly detection
- "No-human in the loop"

Wireless capsule based endoscope with 5G and cloud-based AI

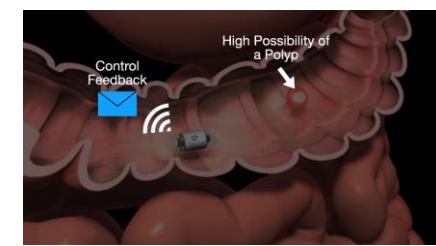
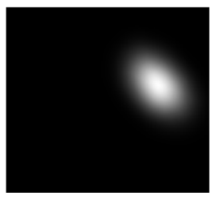
Capsule and backscatter design



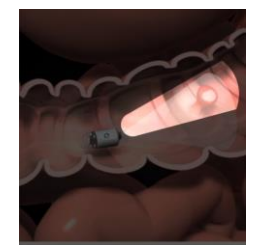
Application architecture and connection via 5G



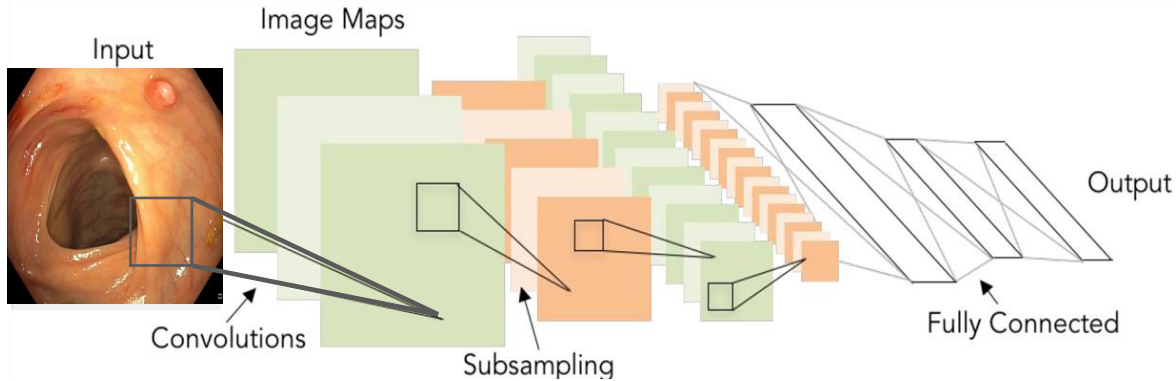
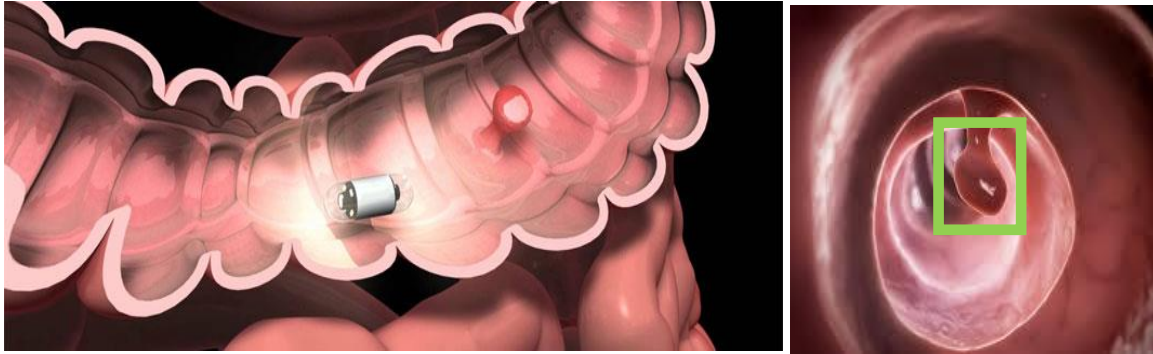
AI/ML based polyp detection



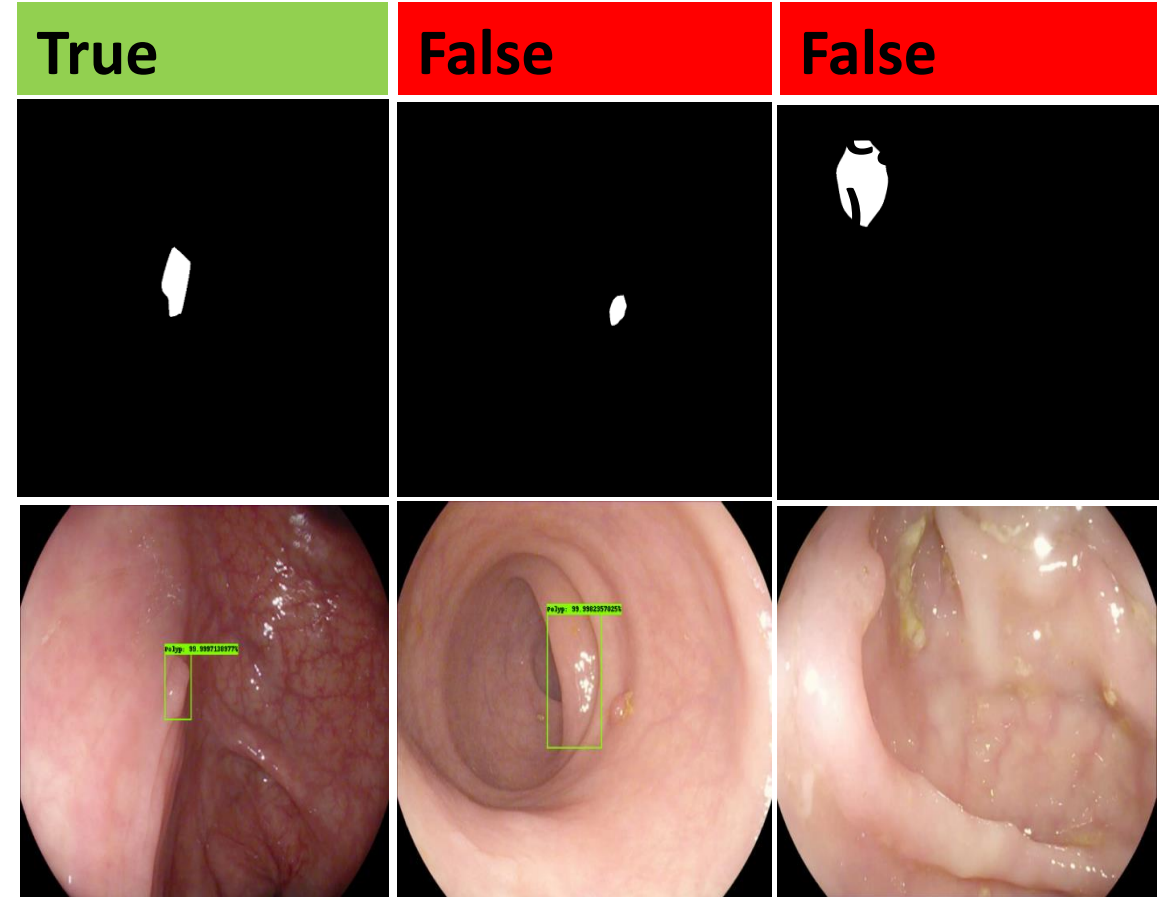
Feedback loop



Developing an algorithm that automatically detects polyps **reduces investigation time**



Deep Neural Network



Presently clinicians miss ca. 25% polyps

Transmission protocols influence on end-to-end latency

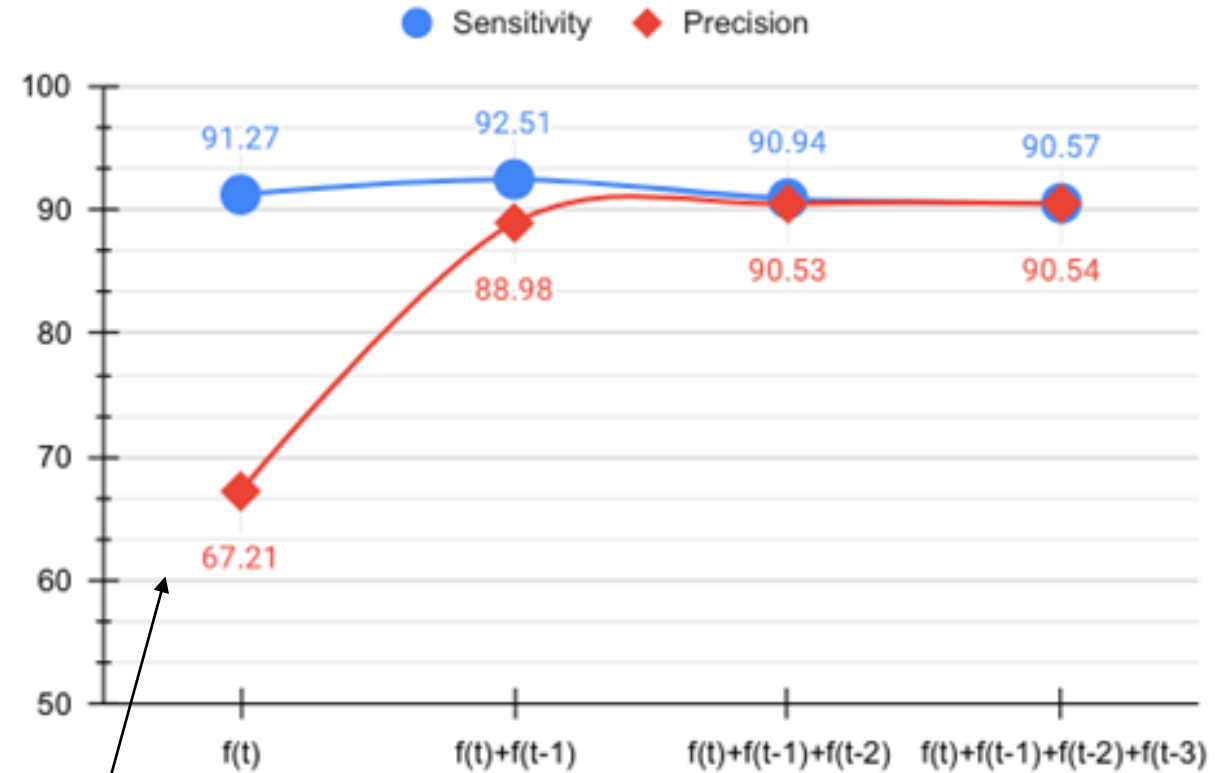
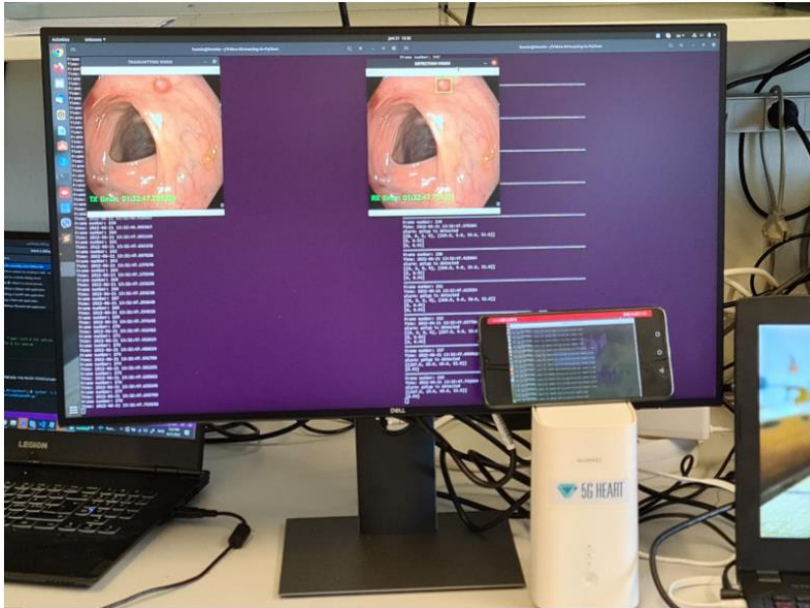
E2E latency tests

End-to-End latency also includes the processing time required by the AI-based detection model per frame which was measured to be 10 msec on NVIDIA RTX 3090

Protocols	Latency [ms]
UDP-RTP	46.74
TCP-RTSP	466.48
TCP-HTTP	240.16

AI Sensitivity and precision

Precision benefits from analyzing the previous frame together with the current frame



High level of false positives

Recommendations from 5G-Heart project results

- The advent of deep learning in the field of capsule endoscopy, with its evolutionary character, could lead to a paradigm shift in clinical activity in this setting.
- The exponential development of the usefulness of AI in capsule endoscopy requires consideration of its medium- and long-term impact on clinical practice.

5G technology enables:

- Real-time video streaming with low latency so that the capsule camera parameters can be optimized on-the-fly for high accuracy polyp detection and minimize the on-board power supply.
- Secure end-to-end transmission using the network slicing allows network resources for time critical, reliable services.

Thank you for your attention

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