ITEA 3

Project Results

STARLIT

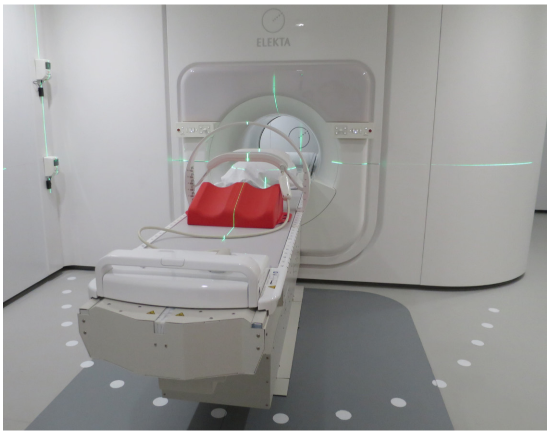
Real-time responses in radiation therapy

EXECUTIVE SUMMARY

By increasing imaging speed and combining cancer interventions and monitoring in real time, the ITEA project STARLIT has developed technology to increase radiation accuracy and decrease unintended dose to healthy tissue. This has the potential to reduce side-effects and improve the quality of life of patients and their families.

PROJECT ORIGINS

The global incidence rate of cancer is expected to grow by 70% over the next two decades, with Radiation Therapy (RT) treatment currently recommended for 52% of new patients. Although radiation oncology has caused a drop in mortality for several cancers, the need remains to reduce side-effects such as incontinence or dysphagia. The solution lies in 'first-time-right' treatment in which a right/decided dose is given to the tumour while keeping the dose to healthy tissue as low as possible to prevent side effects.



The Unity system installed at UMC Utrecht

The STARLIT (System Technologies for Adaptive Real-time MR Image-guided Therapies) project has developed technology improve treatment accuracy and to minimise the unintended dose in image-guided radiation therapy (IGRT). In doing so, it addresses industrialisation aspects required for the next level of complexity, including real-time anatomic, dosimetric and biomarker feedback regarding the tumour site and organs. First and foremost, this improves quality of life for cancer patients by reducing unintended side-effects. It also provides less disruption for their families, increased confidence in oncology and greater efficiency in healthcare as a whole.

TECHNOLOGY APPLIED

STARLIT's technological foundation is Unity, a platform released by Elekta in 2018. By improving Unity's software to speed up imaging, the project has allowed a number of intervention and monitoring processes to be carried out in real time. For intervention, a significant element is functional imaging, which generates functional information beyond just anatomical data. Target imaging and beam-on imaging are also possible. Another key aspect is the capacity to see if the tumour or organ has moved and adjust the treatment in real time, which is enabled via imaging and applied by multi-leaf collimator (MLC) tracking and beam gating. The intervention process also supports both automatic needle placement and brachy source tracking.

The STARLIT system is integrated with low-latency connections and a feedback loop, again allowing for real-time adaption of treatment based on separate monitoring processes. These verify that the delivered dose and the position of the tumour are correct. Two use-cases demonstrate this in practice: MR-Linac (which sends radiation towards the tumour) and MR-Brachy (which irradiates the tumour from inside by a miniature stepping source or permanent seeds inserted via hollow needles). Both make use of high-density radiofrequency (RF) coil arrays for the head/neck and body. The coil is essentially a translucent element, allowing radiation to pass through without altering the patient dose while keeping the patient's anatomy visible for motion monitoring. Camera-based motion detection has also been developed to further improve this visibility. Additionally, each use-case utilises a moving phantom to calibrate the system and to demonstrate that movements can be tracked in real time as a form of quality assurance.

MAKING THE DIFFERENCE

The project's main focus is technical feasibility, resulting in a number of quantifiable results. Most notably, low-latency motion detection for tracking was clinically unpracticable or suffered delays of over 500 ms, whereas STARLIT has created a prototype with delays of just 200 ms. High-resolution imaging has also seen an enormous boost: an echo time reduction from over 100 ms to 70 ms, a 20-30% increase in signal-to-noise ratio and a decrease in distortion from more than 10 mm to less than 1 mm. Additional result was improved MLC tracking algorithms that make use of the faster imaging coupled to low latency dose reconstruction for instant verification of MLC tracking treatments. The integrated system demonstrates the value and validity of the safety architecture in accordance with the newly developed standard IEC TR 62926 (2019).

STARLIT's commercial side has also seen great successes, helping to position Europe for dominance in the MR-guided RT market. The projected annual top-line revenues for the consortium are over USD 650 million after 2020. Real-time tracking is a fundamental step towards a 10% annual growth rate for this market as a whole, while the brachy market may also grow by 20%. SMEs have a unique role as the creators of additional products that improve STARLIT's efficiency, such as the head/neck and body coils and camera systems. The 4D motion phantom with a patented deformable MR/CT/MV tumour target – which reduces measurement latency from over 50 ms to roughly 500 μs and improves target position precision from 1 mm to under 0.1 mm – was used as a QA tool to demonstrate adaptive beam tracking and is now commercially available from Modus QA.

In addition to generating 19 full-time positions within the consortium, STARLIT has led to eight Master theses, one PhD thesis and four new courses at Utrecht University. A user group also exists for Unity, meeting one or two times a year to discuss improvements. This allows potential users, such as hospitals, to first test the system before buying it. Over 80 orders have already been placed in more than 25 countries. Combined with the 51 publications so far, the ongoing standardisation work of Philips and Elekta, and the development of a 4D deformable QA/QC phantom platform by Modus QA, this will drive adoption of the project results for the benefit of patients across the globe.

Promising uptake paves the way for STARLIT's most important result: improved quality of life for patients, who currently go through the radiation procedure up to 20 times. Higher doses with greater accuracy could reduce this to two or three times – perhaps even just once. This means less travel to hospital and fewer side-effects. Philips plans to extend its image-guidance MRI technology to other treatments, such as cardiac catheter intervention, oncological ablations, and neuro-modulation, cascading STARLIT's technology throughout the healthcare system.

MAJOR PROJECT OUTCOMES

Dissemination

- 51 publications and 34 press releases.
- 4 courses and 1 symposium.
- 152 presentations at conferences/fairs.

Exploitation (so far)

- Two different head & neck patient immobilisation devices compatible to different thermoplastic mask systems.
- Updates for the already successful UNITY system, exceeding the target of 80 systems.
- 1900 Compressed Sense software licences until Q2 2020; over 5 million patients have been scanned with it.
- Modus QA Deformable Motion Phantom.

Standardisation

- IEC TC62C WG1 proposal for a standard for the MRLinac system.
- IEC 60601-2-33 MR standard.

Patents

- 13 patent applications filed.

STARLIT
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Partners

Austria
IT-V Medizintechnik

Canada
Elekta
Modus Medical Devices

Netherlands
MR Code
MR Coils
Nucletron Operations
Philips
Quantib
Tesla Dynamic Coils
The Netherlands Cancer Institute (NKI)
UMC Utrecht

Sweden
Akademiska University Hospital
C-RAD
Elekta Instrument

Project start
October 2017

Project end
September 2020

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