Quantitative imaging and artificial intelligence in oncology

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Quantitative Imaging and Artificial Intelligence Oncology

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Socio-cultural impact

The major challenge for precision oncology is to provide tailored personalized treatment to patients to improve the outcome of the treatment and reduce the associated risk of toxicity and relapse. The implementation of decision support systems in clinics will bring a benefit to clinicians and also to patients. The role of radiomics research is evident in precision oncology but currently it is facing several issues. These issues are strongly impacting the possibility to translate research prototypes as decision support systems in the clinic. Through our work we propose an AI-driven technique for automated image analysis and extraction of radiomic features and prediction of the outcome based on the information stored in radiomic features. Since very few studies have been performed in AI in oncology in our part of the world, this work will inspire more and more researchers in the field to perform similar kinds of studies. Our proposed AI infrastructure will be helpful for the research community in this country. Our initiative has already attracted researchers to explore AI based research in oncology in India. In our next project, we have been able to add a research partner in India and implemented our proposed AI infrastructure. Gradually the acceptance of AI-based research in oncology will grow the culture of using AI-based decision support systems in oncology.

Economic Impact

Cancer therapy is gradually evolving from conventional treatment to personalized treatment. In the last few years, treatment options have increased drastically. Besides the utilization of conventional surgery, radiotherapy, and chemotherapy, newer treatment options like robotic surgery, image-guided radiotherapy, proton therapy and targeted immunotherapy or molecular therapy have opened up new horizons for patients. These treatments offer better efficacy and fewer complications and toxicity. A physician's decision to select the best treatment is driven by clinical judgment based on various parameters derived from diagnostic tests which are often subjected to the clinical acumen and expertise of the treating physician. Sometimes a decision becomes very difficult for the doctors and patients if there is a lack of strong evidence or differential costs involved. Several biomarkers have been developed helping in the decision, however, there are certain issues with the use of biomarkers: a) biomarkers are only helpful to guide the decision making for targeted therapies and do not have much benefits in decision making to select conventional treatment like surgery, radiotherapy and chemotherapy and b) biomarker testing is expensive and time-consuming. Imaging biomarker-based decision support systems presented in this thesis may be a game-changer in this scenario because of multiple reasons: a) imaging biomarkers can be derived from images already performed so no additional cost is involved, b) imaging biomarkers can be developed based on retrospective data and applied prospectively so evidence building can be achieved quicker and with much less cost, c) imaging biomarkers can be developed for conventional as well as targeted treatments d) imaging biomarker parameters can be obtained instantaneously with no delay in treatment

Technological impact

Although technical development was not the main aim of this thesis, it addresses three major technical issues related to the implementation of AI in oncology. We developed a GUI consisting of a) a data harvesting pipeline (ETL module), b) a GUI based radiomics extraction pipeline, c) a pipeline for RDF conversion of clinical, radiomic and DICOM data, and d) an RDF data server adhering to FAIR data principles for distributed and centralized machine learning. Philips as a corporate partner of the project has deployed Intellispace Discovery (research-only build; Philips Medical System, Eindhoven, The Netherlands) for research and development for the BIONIC project. We are using this system for various activities like image visualization and manual and automatic contouring of the GTV. The pipelines developed in this thesis can be integrated into Intellispace discovery for research or clinical uses. Intellispace discovery will thus be able to provide an automated solution for radiomic feature extraction and conversion of data into RDF format by integrating pipelines developed in this thesis with existing DL based auto contouring.