PhD Fellowship on Dynamic Generative Modelling for medical applications

Thesis location : Laboratory of Medical Information Processing (LaTIM), French Institute of Health and Medical Research (INSERM UMR 1101), Brest, France,

Period : 3 years, starting on October 2020.

Context and objectives :

Among deep learning approaches, generative models (GMs) in particular based on GANs (Generative Adversarial Networks) are gaining a lot of interest in medical imaging. Potential applications of GMs are diverse: generation of pseudo-computed tomography (CT) from magnetic resonance images (MRI) for attenuation correction in positron emission tomography, synthesis of MRI for automatic organ segmentation; standardization; anonymization, data enhancement, ...

However, one of the current limitations of GMs in a medical context is the lack of consideration for the temporal component, which is present in many medical signals leading to dynamic images (widely known as 4D). This is for example the case in radiotherapy treatment planning for lung cancer, where an objective of GMs would be to reduce the number of dynamic CT acquisitions necessary to account for respiratory motion effects, hence lowering the overall radiation dose delivered to the patient.

Within this context, the objective of this PhD thesis is to develop a deep learning-based generative architecture for dynamic medical image synthesis. Such models would constitute a major innovation in medical imaging, an example of which is provided in Fig. 1. A growing literature around these topics outside medical imaging in the field of computer vision will be the starting basis for the work of the doctoral student.

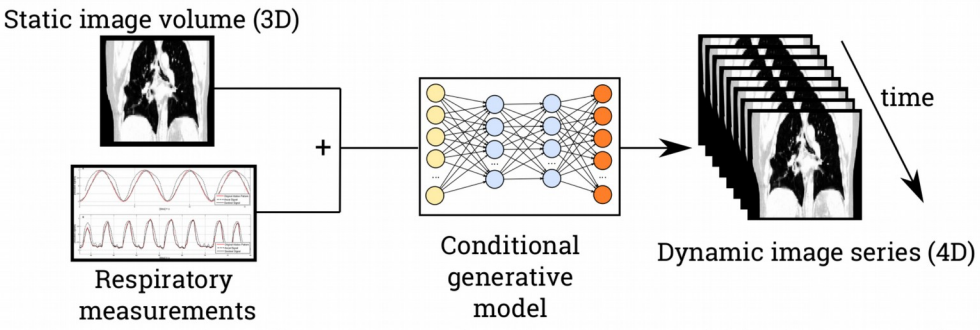

Fig. 1: Example of proposed workflow using a conditional generative model for the creation of respiratory synchronised 4D CT images from a single 3D CT image and patient specific respiratory measurements.

Qualifications :

Education : The candidate must hold a Master's degree in one of these domains : physics, electrical/electronic engineering, computer science, applied mathematics.

Scientific interests : Good understanding of the physics of medical imaging and its challenges.

Programming skills : Fluent data processing using scripting langages (UNIX shell/python/Matlab).

Languages : English (complimentary), French (optional).

Contacts : Send before April 30th (in French or in English) CV, grades/marks (whatever currently available if you are actually on a Master), and a brief statement of interest by email to : Vincent Jaouen : vjaouen@gmail.com and Dimitris Visvikis (dimitris.visvikis@inserm.fr).

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Parmi les approches d'apprentissage profond, les modèles génératifs (MG) en particulier basés sur les GANs (Generative Adversarial Networks) suscitent un fort intérêt en imagerie médicale. Leurs applications sont nombreuses : génération de pseudo-tomodensitométrie (scanner) à partir d'images de résonance magnétique (IRM) pour la correction d'atténuation en imagerie de tomographie d'émission de positons, synthèse d'IRM à partir de scanner pour la segmentation automatique d'organes ; standardisation; anonymisation, augmentation de données, ...

Une des limites actuelles des MG dans un contexte médical est toutefois l'absence de prise en compte de la composante temporelle, présente dans de nombreux signaux médicaux et conduisant à des images dynamiques (souvent dénommées 4D). C'est par exemple le cas pour la planification des traitements de radiothérapie dans le cadre du cancer du poumon, où un objectif des MG serait de réduire le nombre d'acquisitions de tomodensitométrie dynamique nécessaires pour tenir compte des effets des mouvements respiratoires, réduisant de ce fait la dose globale de rayonnement délivrée au patient.

Dans ce contexte, l'objectif de cette thèse de doctorat est de développer une architecture générative générique basée sur l'apprentissage profond pour la synthèse d'images médicales dynamiques. Si de tels modèles constitueraient une innovation majeure en imagerie médicale, il existe une riche littérature autour de ces sujets en vision par ordinateur hors du contexte médical sur laquelle le doctorant pourra appuyer ses travaux.

EN

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