PhD subject

# Modeling the evolution of breast's shape and appearance during radiotherapy

## Hosting institute

— ICube laboratory: Le laboratoire des sciences de l'ingénieur, de l'informatique et de l'imagerie (The Engineering science, computer science and imaging laboratory), http://icube.unistra.fr/

— University of Strasrboug, France, http://www.unistra.fr/

## Work place

Place de l'hôpital, Strasbourg (67), France.

## Supervisors

— Hyewon Seo (ICube, Univ. Strasbourg)

— Michel De Mathelin (ICube, Univ. Strasbourg)

— George Noel (Univ. Strasbourg and Centre Paul Strauss)

## Staring date

September/October 2020.

## Subject description

Breast radiotherapy after conservative breast surgery is a systematic step in the treatment of breast cancer. As a mobile external organ, the mammary gland is subject to several uncertainties regarding daily breast positioning, which makes it a hard subject to measure and study. These uncertainties depend on systematic and stochastic daily errors including at least positioning errors, respiratory moves, seroma involution and oedema/inflammation phenomenon. For instance, average intra-fractional respiratory motion of the chest in the antero-posterior direction has been evaluated to be -1.4mm (values from -8.8 to 9.3 mm) [1]. In addition to those factors, lack of reproducibility between the inter-fractional positioning can be induced by the arm elevation required to avoid its irradiation during treatment. Indeed, a regular clinical examination of patients during the irradiation treatment shows frequent cases of progressive changes in breast morphology due to inter-fraction positioning variability and possibly also to radiation-induced inflammation [2, 3, 4, 5]. Yet, little is known about the morphological variations of the breast and their impact on the treatment quality.

The advent of imaging technology has allowed effective measurement and analysis of breast size and shape, attracting interests by plastic surgeons, brassier designers, etc. Much work remains, however, before 3D scanning systems can be successfully used in automated analysis of the breast—filtering noise, filling holes, and, in case a temporal evolutionary analysis is desired, finding correspondence among each scan data.

In this study, we will focus on the problem of breast shape modeling, with a specific aim to examine the morphological change of breasts (shape and size as measured by the volume) during the post-operative irradiation therapy. We will use the colored surface scans of more than 60 patients acquired by a hand-held scanner and develop related surface processing techniques, based on our previous work [6, 7]. If necessary, we will acquire datasets more subjects, in collaboration with Centre Paul Strauss. Our specific aims are articulated as follows.

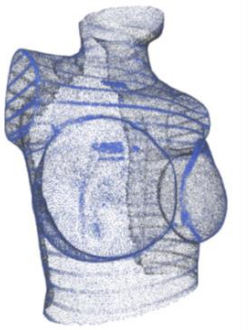

*Figure 1: Breast identification and extraction on the point cloud data. The blue dots around the breast boundary represent the "lead wire".*

1. To develop computational tools that will allow the computer-assisted monitoring of evolution of breast's shape and appearance over time (Figure 1). A template-based approach combined with dense point-to-point correspondence is considered, to circumvent the problem of sagged breast with occlusions and to facilitate the problem of surface completion.
2. To statistically model the evolution of breasts according to several known factors (arm pose, breathing, age, body weight, initial breast shape characteristics, therapy, etc.), based on the dataset. This will require a surface correspondence among a sufficiently large number of subjects, as well as a compact representation of the shape under consideration. We will deploy nonlinear statistical models, to precisely model the variability across individual shapes as well as their changes over time.
3. To propose a new, personalisable breast irradiation protocol that takes the modeled/observed variation into account. Today, the radiation dose delivered to the breast tissue during the radiotherapy is calculated at the initial phase of the radiotherapy as a function of the morphology and the layout of the tissues, based on the assumption that their shape as well as size are fixed and reproducible throughout the therapy. The new protocol will propose to readjust the parameters of irradiation throughout the irradiation sessions, based on the qualitative and quantitative evaluation of the breast evolution under consideration.

## Requirements

— Master's degree in computer science or equivalent

— Working skill of programming

— Experience in surface processing and modeling is a plus

## Bibliography

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