Simulating compression of a breast can lead to better detection of cancer

By: Rebecca Axelsson
Department of Biomedical Engineering, Lund University, Sweden

Cancer is a major cause of death worldwide. For women, breast cancer has the highest frequency of all cancer types and affects roughly 2 million women worldwide every year.

Mammographic screening is seen as the golden standard when it comes to the early detection of breast cancer. However, not all cases of cancer are detected as their characteristics are too similar to the background or too small in size to be detected. Moreover, there are also cases in mammography when it is unclear whether a tumour is benign or not.

What if there was a way to detect these cancers as well as determine which type of tumour it is?

The idea in this project is that it can be solved by ”mechanical imaging”. Mechanical imaging of the breast has been done by loading the breast between two plates and measuring the surface stress in order to assess its mechanical properties. The reasoning for why it works in detecting cancers it is that tumour tissue is generally stiffer than normal breast tissue. This will result in an area of local high stress on the surface of the breast, at the location of the tumour.

What if it was possible to validate the results of this particular method in a relatively short amount of time?

This second question can be addressed with ”virtual clinical trials” which are simulations of clinical trials. They include the generation of tissue and can be used to validate medical imaging systems. In this particular project we have used the breast models from an open-source software platform. The simulation times in this software, *OpenVCT*, are quite short and seems to be advantageous to be used in combination with mechanical imaging.

A tumour was simulated within the breast in order to investigate if the model could produce the same stress patterns seen as seen in real breasts using mechanical imaging. Subsequently, the size, stiffness, and location of the tumour was varied to systematically determine their influence on the stress pattern. After the insertion of the tumour, the breast was compressed and the resulting stress patterns at the top of the breast was recorded.

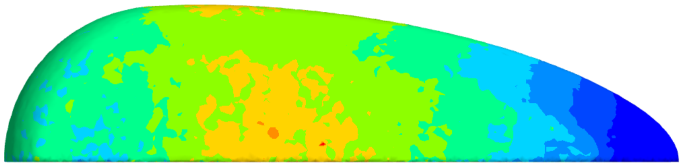

Fig. 1: Stress pattern at the surface of a simulated compressed breast with no tumour inside.

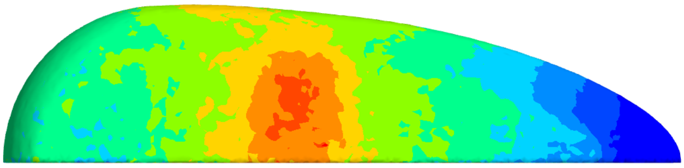

Fig. 2: Stress pattern at the surface of a simulated compressed breast. A tumour which is 50 times stiffer than the breast is located in the middle of the breast.

With the inclusion of a tumour in the breast there was a local area of increased stress at the tumour’s location, just as reported clinically. Moreover, the average stress of the breast model was within the range of stress reported in literature.

It was also found that with increasing size and stiffness of the tumour the local area of high stress increased. Between having no tumour as seen in figure 1 and having a tumour which was 50 times stiffer than the breast (figure 2), there was a 19% increase in stress at the tumour’s location.

In the future, the breast model will become even more realistic if more different tissue types could be included. The final outcome could aid in clinical studies regarding mechanical imaging by modelling cases which are rarely seen or to characterize the stress patterns of certain cancer types.