Image-Fusion and Breast Lesion Analysis for a later AR application to improve surgery outcomes

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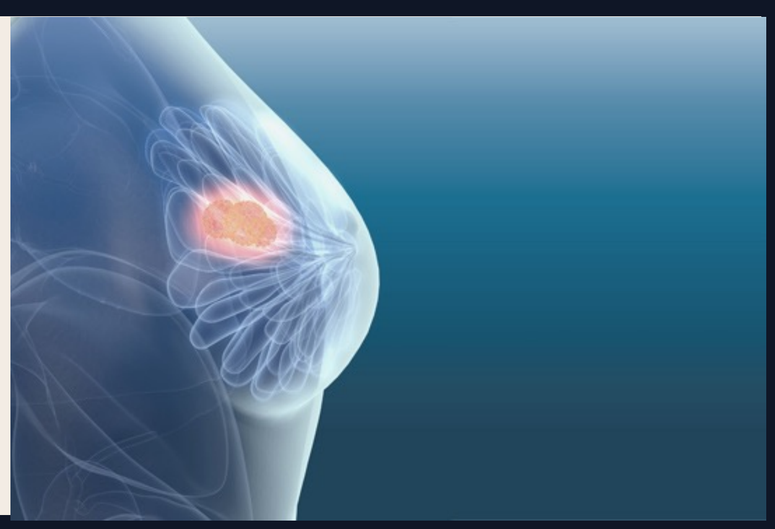
Objective

Our goal is to detect and segment breast tumor by using a deep neural network. We, in collaboration with Tel Hashomer Hospital, will build a fully automated detection and segmentation framework that adaptively chooses its parameters, after fusing the information from different imaging modalities.



Selected Approach

The project model will be based on:

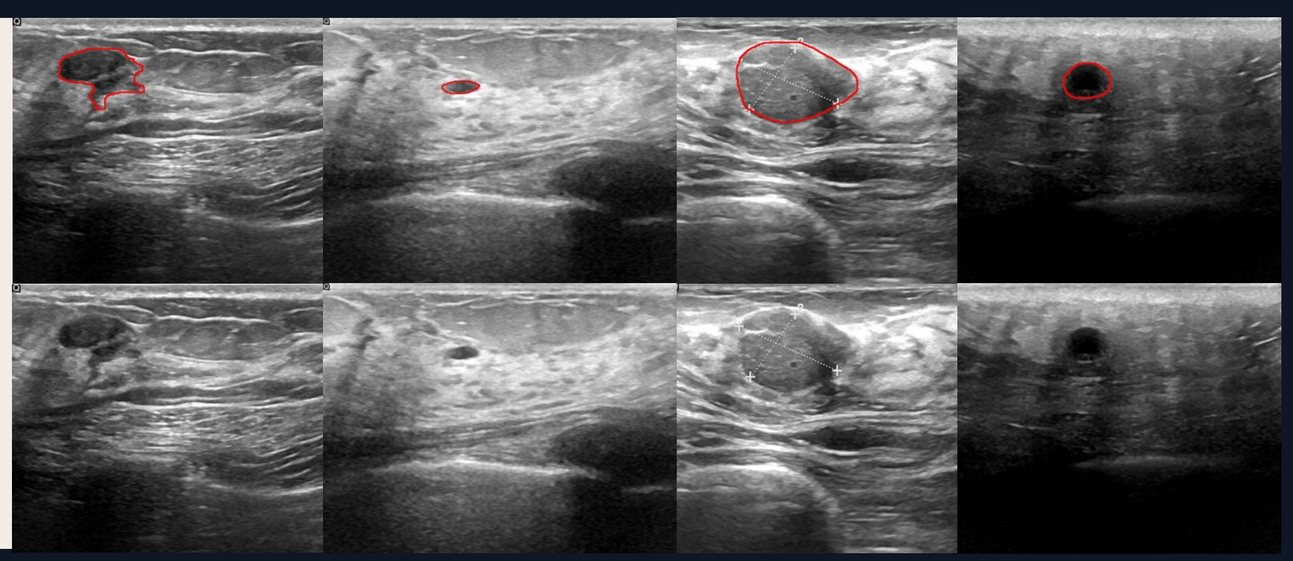
- Image fusion.
- Detection and Segmentation of the cancer lesion.
- Projection on the patient body by Augmented Reality (AR).

Introduction

Breast cancer is one of the most common cancers among women worldwide. Unfortunately, in many cases the surgery achieves only partial success, which results in a re-operation with its accompanied risks. On the other side, there are many cases in which the surgeon removes too much of the breast tissue. Therefore, developing a method for accurate analysis of cancer lesions (in a non-invasive way), will maximize the operation success. We present an end-to-end lesion analysis framework.
Later, the lesion will be adapted to the patient's posture during the operation and will be included in an Augmented Reality application to help the surgeon (real-time). We expect that the impact of such a project will be highly significant, including less re-operative procedures, minimizing costs, hospitalization days, and surgery complications.

Methods

We use a known detection & segmentation method such called UNET, followed by a Level-Set (which is a method also used for fine-segmentation) and by connecting these two we can get much better segmentation. The integrated framework chooses the level set parameters adaptively and specifically for each lesion.

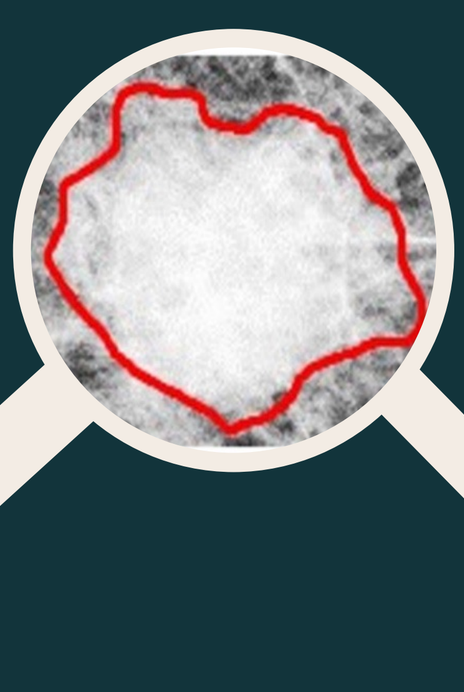


Solution Description

- **UNET :** This CNN architecture is designed in a U shape. This network proved itself in a lot of image segmentation projects. The main benefit of this architecture is that we don't need a lot of data to train the model. It can be represented by two main steps the Left side of the U shape (Down) and the Right side (Up). The First one (the left side) is responsible for extract the main feature from each image and lower the resolution (Encoder) The second side (the right one) gets two inputs **1)** the left side outputs from each layer **2)** the output of his previous layer. The down stream gets the original image and preforming three convolution layers and max pooling this action is done 4 times, the up stream uses his inputs, concats and Decodes them until we will get the probability matrix(mask) in the original image size which 1 represent tumor.
- **Level-set:** after the Unet part we'll take it output and put it in the Level-Set, Level-Set Using gradient decent which minimizing an associated energy functional and by that evolves the contour to a more accurate shape.
- **Image Fusion:** To extend our knowledge about the "scene", we will fuse the whole imaging information that we will have on hand (e.g., Mammography, MRI).

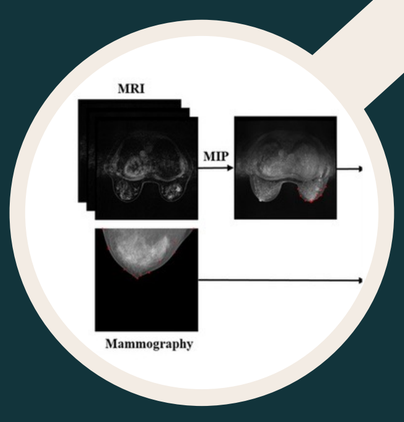
Lesion Analysis

Detection and segmentation of the lesion



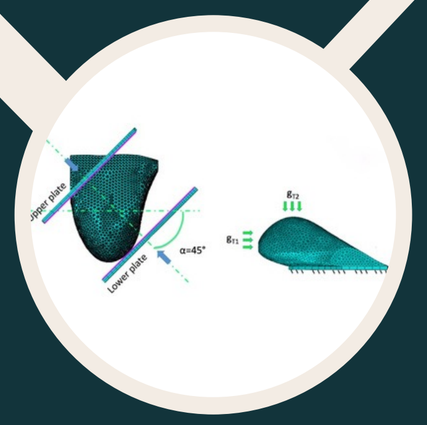
Modality Fusion

Obtain an MRI or mammogram of patient for analysis



Posture Adaptation

Segmentation by the patient pose using registration



Projection by AR

The doctor can aim his tablet to the patient and in few seconds, it will mark the lump