Spectral Imaging: Breast Density Measurement Using MATLAB Coder

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Agenda

• Breast Cancer Burden overview
• Philips MicroDose Mammography
• Problem Definition
• Challenges Encountered
• Approach to Solution
• Conclusion
Disease Burden – India

Real cancer incidence estimated 1.5-2.0 times higher than reported incidence.

Risk factors
- Hormone replacement therapy
- Obesity
- Lack of exercise
- Later age at first child birth
- Lack of Breast-feeding
- Family history

Reluctance in asymptomatic screening due to reactionary culture also leading to diagnosis at later stages.

5% (India) vs. 1.5% (USA) mortality among incidences

E&Y – Call for action: Expanding cancer care in India, 2015
MicroDose Mammography

- MicroDose Mammography.mp4
- Outstanding innovations
  - Low dose
  - High Image quality
  - Breast Density Measurement

Source: http://www.usa.philips.com/healthcare/product/HC714047US/microdose-mammography-si
Tomosynthesis (3D Mammography)

• 3D Breast Imaging
  - Creates a 3D picture of the breast using X-rays

• Advantages
  - High Cancer detection rate
  - Low Recall rate

• Tomographic reconstruction algorithm used to generate 3D/2D images

References:


BDM (Breast Density Measurement)

• What is it!
  - Identifies the Breast Composition
  - Dense Breast:
    (i) Higher Risk
    (ii) Lower Sensitivity and Specificity

• Traditionally:
  - Visual or computer-assisted assessment of 2D Mammogram (e.g. BIRADS score, Cumulus)

• Volumetric Density Assessment:
  - Estimation of actual Fibro-glandular tissues
  - Higher Consistency
BDM Advantages

Advantages:
- Improved risk estimates
- Personalized screening
- Temporal monitoring
- Therapy response
- Better dose estimates
Problem Definition

Problem Statement:
• Having a reliable & accurate BDM algorithm in MATLAB, how to get this into Production environment

Solution Options:
1. Get the MATLAB code directly in Product
2. Convert code from MATLAB to C++ manually from scratch
3. Or Look for some automated and Reliable option that can convert code from MATLAB to C++
Approach

• Option 1:
  Ruled out, as further optimizations are required.

• Option 2:
  Ruled out, as lot of Expertise, Resources and Time is required.

• Option 3:
  Can check it out.
  Found that MATLAB provides some tool known as MATLAB Coder to convert the code automatically
So, let's check out ‘MATLAB Coder’ 😊

• Expectations from MATLAB Coder:
  ➢ To get exactly same output from C++ as from MATLAB.
  ➢ To get the precision correct at least up to 6 decimal places.

• To start with MATLAB Coder we needed:
  ➢ Huge Data set, to verify MATLAB Coder output
  ➢ Boundary cases for code conversion.
Challenges

Challenges Faced:

• Regular updates in Original MATLAB code
• MATLAB Code not Coder Ready
• Instances when results were mismatching.
• Output validation (MATLAB output vs. C++ output)
MATLAB & MATLAB Coder

Benefits:

• Design issues resolved early in development
• Rapidly assessed and converted
• Development process overhead reduced
• Algorithm validated in days
• Consistent output
• High accuracy

Support from Mathworks:
During this exercise the support from the Mathworks technical support team was commendable.
## MATLAB Vs. C++ Output

### Matlab:

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<tr>
<th>Data Set No.</th>
<th>Param_1</th>
<th>Param_2</th>
<th>Param_3</th>
<th>Param_4</th>
<th>Param_5</th>
<th>Param_6</th>
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# MATLAB Vs. C++ Output

## Relative Error:

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Conclusion

• Highly interactive tool to use.
• Obtained optimal results using MATLAB Coder.
• Minimal relative error output between MATLAB & C++.
• Eliminated the C++ implementation effort significantly.

Recommend to use MTALAB Coder.
Appendix

The original BDM Algorithm in MATLAB is written by – Sr. Scientist Erik Fredenberg, from Sweden.