

User Guide for 2D Parametric Breast Model GUI

1 Introduction

This brief guide has been provided to assist the user step-by-step in creating the labels with the 2D compressed breast model implemented in our GUI. It is designed to enhance the interface's intuitiveness, making it easier to navigate and understand. By following this guide, users can efficiently utilize the GUI's features, ensuring accurate and consistent results in model creation.

2 Setup

First, to launch the 'parametric_breast_model_GUI' function, the user must define the paths for the shape parameters extracted from real mammograms, which can be found in 'real/mammograms_parameters/all_mammograms_parameters' in the GitHub repository of this project. The section of code that requires modification, along with detailed instructions, can be found from line 9 to line 24; see Fig. 1.

Secondly, the user needs to choose the default parameters, which are those of the base model, that will be displayed when the GUI opens. By default, the GUI will open with the parameters of the first mammogram in the selected dataset (this setting is found from line 157 to line 167; see Fig. 2 in the red box). Alternatively, the user can set random parameters within the range of those extracted from real mammograms (from line 134 to line 141; see Fig. 3 in the red box). Finally, the user can set the default parameters to the median values of the parameters extracted from real mammograms (from line 145 to line 152; see Fig. 3 in the blue box).

3 Label Generation

Once the setup is complete, the user can launch the interface by calling the function 'parametric_breast_model_GUI' from the Command Window. If the user has kept the default settings, the interface will appear as shown in Fig. 4.

The GUI is divided into three panels the user should complete in the order they appear: 'Shape & Skin Thickness,' 'Fibroglandular Tissue,' and 'Tumors.' To guide the user through this sequence, only the features of the first panel are enabled upon opening the GUI, while the others remain disabled.

```

1 function parametric_breast_model_GUI
2
3
4 % The run of this function displays a graphical interface for creating a
5 % 2D parametric breast model. Before using this function users have to set
6 % the paths of the breast shape parameters.
7
8 %%%%%-----PATHS SETTING-----%%%%%
9 % Parameters loading (we extracted these breast shape parameters from the
10 % mammograms in our selected dataset).
11 load('', 'a_tot'); % Insert here the path of the file a_tot.mat
12 a = a_tot;
13 load('', 'b_tot'); % Insert here the path of the file b_tot.mat
14 b = b_tot;
15 load('', 'phi_tot'); % Insert here the path of the file phi_tot.mat
16 phi = phi_tot;
17 load('', 'X0_tot'); % Insert here the path of the file X0_tot.mat
18 X0 = X0_tot;
19 load('', 'Y0_tot'); % Insert here the path of the file Y0_tot.mat
20 Y0 = Y0_tot;
21 load('', 'Alpha_e_tot'); % Insert here the path of the file Alpha_e_tot.mat
22 Alpha_e = Alpha_e_tot;
23 %%%%%%
24 % Background colors
25 background_color = [0.9 0.9 0.9];

```

Figure 1: The red box highlights the section of code where the user needs to add the paths for the total parameters extracted from real mammograms in order to run the GUI.

```

154 % By uncomment the following lines (from 156 to 166), the default breast
155 % shape parameters will be the ones corresponding to the specified mammogram of
156 % the selected dataset
157 mammogram = 1; % By default, the user can pick the parameters of the first
158 % mammogram but also can change this value to pick the parameters of one of
159 % the 163 mammograms in the selected dataset
160 a_m = a(mammogram);
161 if a_m >= 1; a_m = round(a_m,3,"significant"); else; a_m = round(a_m,2,"significant"); end
162 b_m = b(mammogram);
163 if b_m >= 1; b_m = round(b_m,3,"significant"); else; b_m = round(b_m,2,"significant"); end
164 phi_m = phi(mammogram);
165 x0_m = X0(mammogram);
166 y0_m = Y0(mammogram);
167 alpha_e = Alpha_e(mammogram);
168

```

Figure 2: In the red box, the section of code that sets the default parameters to those of the first mammogram in the selected dataset is highlighted.

3.1 Shape & Skin Thickness

In the first panel, the user can adjust the breast shape parameters and insert the skin thickness, with the option to modify its thickness.

A slider controls each shape parameter. The parameter it represents is la-

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132 % By uncomment the following lines (from 133 to 140), the default breast
133 % shape parameters will be random values from the range of extracted parameters
134 % a_m = min(a) + (max(a)-min(a)) .* rand(1,1);
135 % if a_m >= 1; a_m = round(a_m,3,"significant"); else; a_m = round(a_m,2,"significant"); end
136 % b_m = min(b) + (max(b)-min(b)) .* rand(1,1);
137 % if b_m >= 1; b_m = round(b_m,3,"significant"); else; b_m = round(b_m,2,"significant"); end
138 % phi_m = min(phi) + (max(phi)-min(phi)) .* rand(1,1);
139 % X0_m = min(X0) + (max(X0)-min(X0)) .* rand(1,1);
140 % Y0_m = min(Y0) + (max(Y0)-min(Y0)) .* rand(1,1);
141 % alpha_e = min(Alpha_e) + (max(Alpha_e)-min(Alpha_e)) .* rand(1,1);
142
143 % By uncomment the following lines (from 144 to 151), the default breast
144 % shape parameters will be the median values of the extracted parameters.
145 % a_m = median(a);
146 % if a_m >= 1; a_m = round(a_m,3,"significant"); else; a_m = round(a_m,2,"significant"); end
147 % b_m = median(b);
148 % if b_m >= 1; b_m = round(b_m,3,"significant"); else; b_m = round(b_m,2,"significant"); end
149 % phi_m = median(phi);
150 % X0_m = median(X0);
151 % Y0_m = median(Y0);
152 % alpha_e = median(Alpha_e);
153

```

Figure 3: In the red box, the section of code that sets the default parameters to random values within the range of those extracted from real mammograms is highlighted. In the blue box, the section of code that sets the default parameters to the median values of the parameters extracted from real mammograms is highlighted.

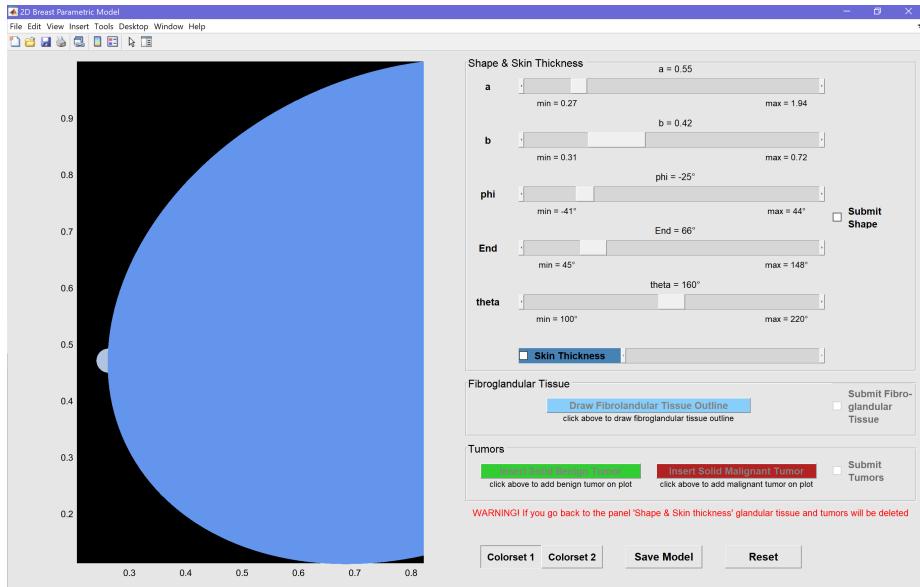


Figure 4: Display of the GUI with the 2D parametric breast model implemented upon opening, using color set 1.

beled to the left of each slider. At the bottom left of each slider, you will find

the minimum value of that parameter, extracted from the real mammograms in the selected dataset. In contrast, the maximum value is displayed at the bottom right. The current parameter value is shown at the top center of each slider. The user can adjust the parameters by dragging the slider bar or by clicking the arrows at its ends.

The last feature of the panel allows the user to insert skin thickening. By checking the checkbox, skin thickening is applied, and the corresponding slider is enabled to adjust skin thickness.

Once the parameters have been chosen and the decision to include or exclude skin thickening has been made, the user must check the 'Submit Shape' checkbox to enable the features of the next panel; see Fig. 5. If the user wants to make changes to the first panel after checking the checkbox, they can uncheck it to re-enable the features of the first panel.

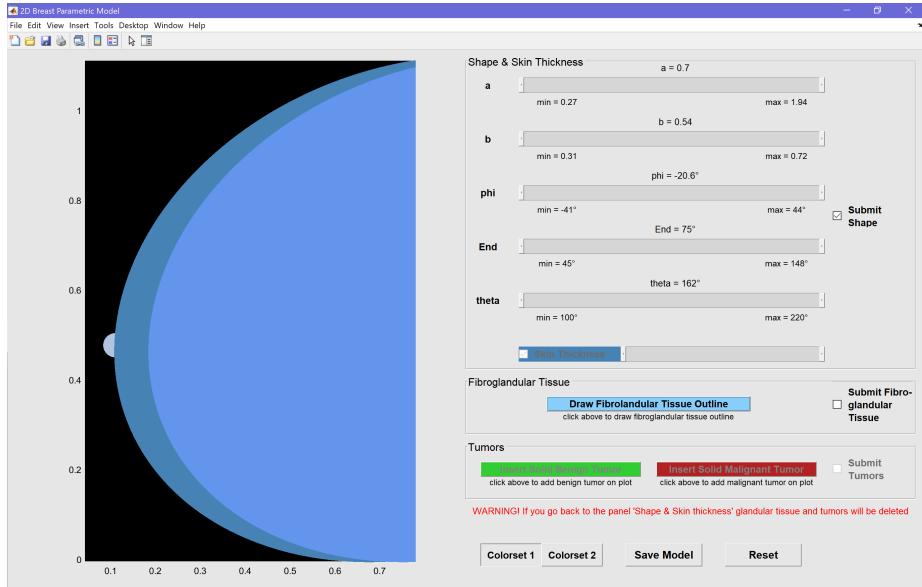


Figure 5: Display of the GUI with the 2D parametric breast model implemented after completing the first panel, using color set 1.

3.2 Fibroglandular Tissue

The second panel allows for the addition of the fibroglandular tissue region. By clicking the 'Draw Fibroglandular Tissue Outline' button, users can outline the fibroglandular tissue region freehand. The user can click on the model and drag the mouse to outline the fibroglandular tissue. Once the user releases the mouse, the outlined region will be surrounded by markers. Markers can be added by double-clicking on the outline or removed by right-clicking a marker and selecting the 'Remove Waypoint' option. Markers can be moved to adjust

the shape of the fibroglandular tissue, and the tissue itself can be repositioned within the breast.

After the insertion, the button for outlining is disabled, as only one fibroglandular tissue region is allowed per mammogram. To delete and redraw the newly drawn region, the user must return to the first panel by unchecking and then rechecking the 'Submit Shape' checkbox. Unchecking this checkbox removes the fibroglandular tissue, and rechecking it enables the 'Draw Fibroglandular Tissue Outline' button again in the second panel.

Once this phase is complete, the user should check the 'Submit Fibroglandular Tissue' checkbox to hide the markers; see Fig. 6.

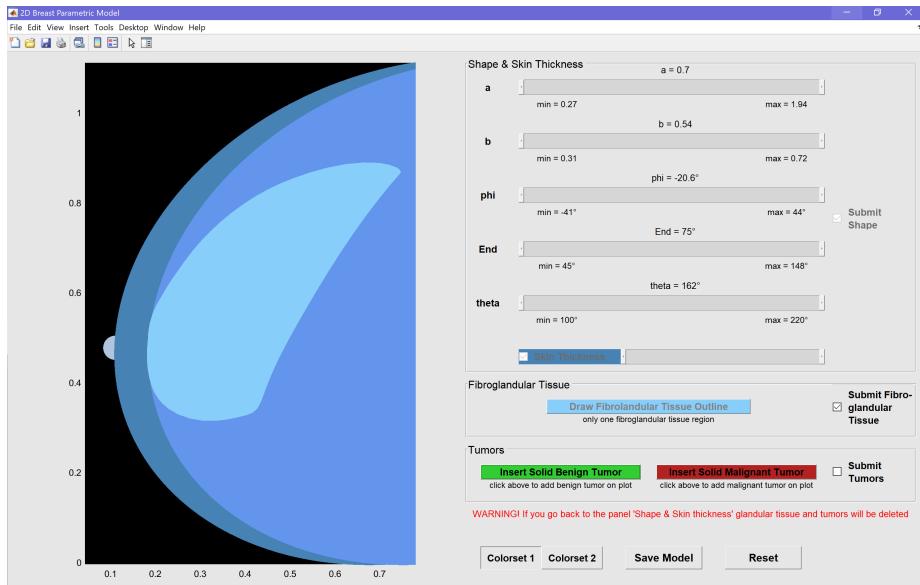


Figure 6: Display of the GUI with the 2D parametric breast model shown after completing the second panel; color set 1.

3.3 Tumors

In the third panel, the user can add both malignant solid tumors using the red push button and benign solid tumors using the green push button. After pressing one of these buttons, the user should click on the model and drag the mouse to draw the major axis of the ellipse representing the tumor. Once the tumor is added, four markers delimiting the ellipse's axes become visible and selectable; these allow the user to adjust the lengths of the axes. The user can also rotate and move the tumor within the model. Additionally, the user can delete the newly added tumor by right-clicking on it and selecting 'Delete Ellipse'. To disable the markers and prevent further modifications, the user

should check the 'Submit Tumors' checkbox, which will also disable the tumor-related pushbuttons, preventing further additions. To modify or add tumors again, uncheck the 'Submit Tumors' checkbox; see Fig. 7. At this stage, it is also possible to return to modify the fibroglandular tissue by unchecking the 'Submit Fibroglandular Tissue' checkbox. Note that unchecking the 'Submit Shape' checkbox automatically removes both tumors and the fibroglandular tissue region.

If the user wishes to create a mammogram without tumors, they only need to check the 'Submit Tumors' checkbox without adding any tumors.

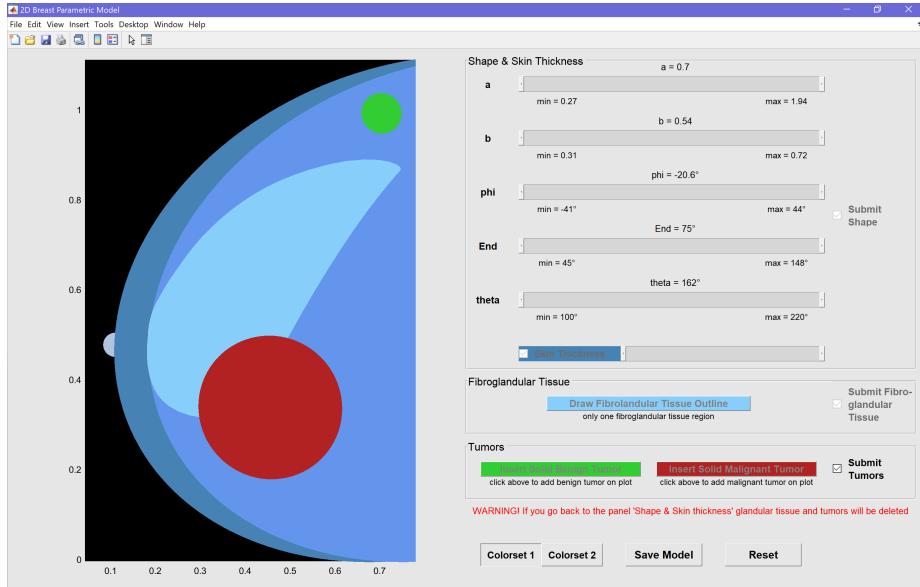


Figure 7: Display of the GUI with the 2D parametric breast model shown after completing the third panel; color set 1.

3.4 Color Sets

Once the model is completed, the user can choose the color set to use; please look at Section IV.A of the article for more details. Selecting color set 2 will change the model's appearance in Fig. 7 to that in Fig. 8.

The authors recommend using color set 1 for presentations, articles, and similar materials and color set 2 for training and generating synthetic mammograms.

3.5 Reset

The 'Reset' button allows you to restore the model to its default state, which is the state when the GUI is initially opened; see Fig. 4.

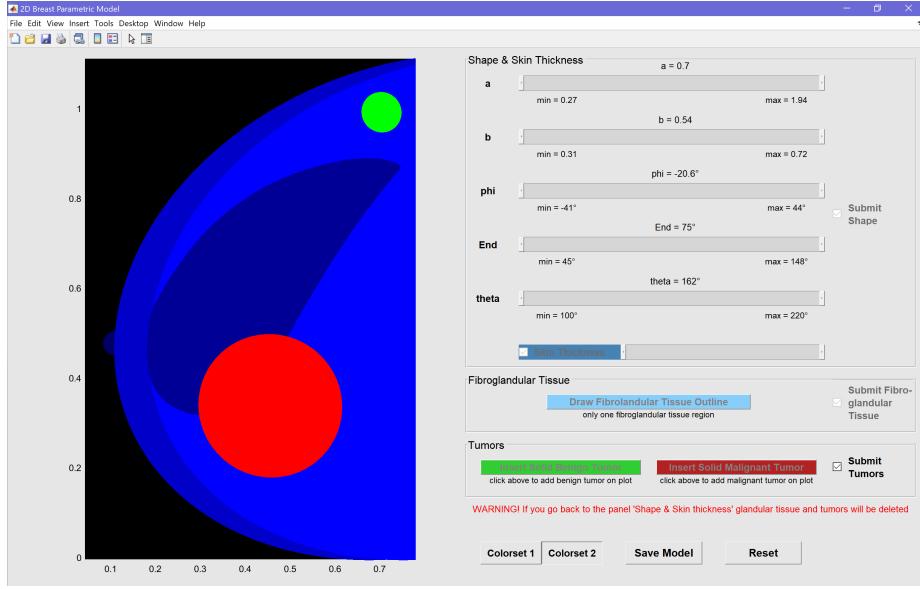


Figure 8: Display of the GUI with the 2D parametric breast model implemented after completing the third panel; color set 2.

3.6 Save

Once the breast model is completed, the user can save it using the 'Save Model' push button. This will open a dialog box where you can select the destination, file name, and format (the authors recommend using the default .png format). The saved image will look like the one shown in Fig. 9.

Note that the model saved this way cannot be used directly for training and generation. It must be passed to the function 'from_model_to_512x512.m' to be scaled to the size of 512x512; see Fig. 10.

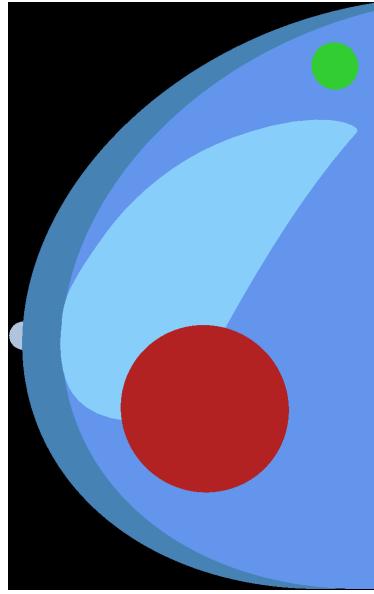


Figure 9: Model saved in .png format; using color set 1.

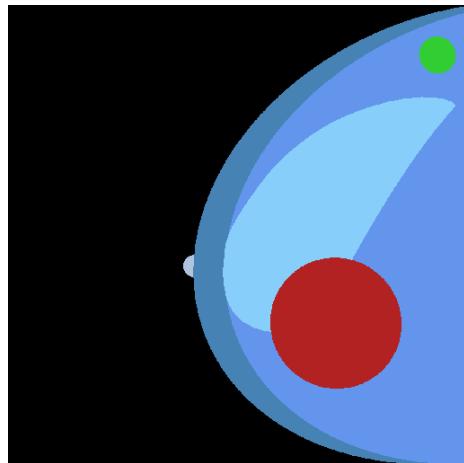


Figure 10: Model resized to 512x512 using the 'from_model_to_512x512.m' function, in .png format; color set 1.