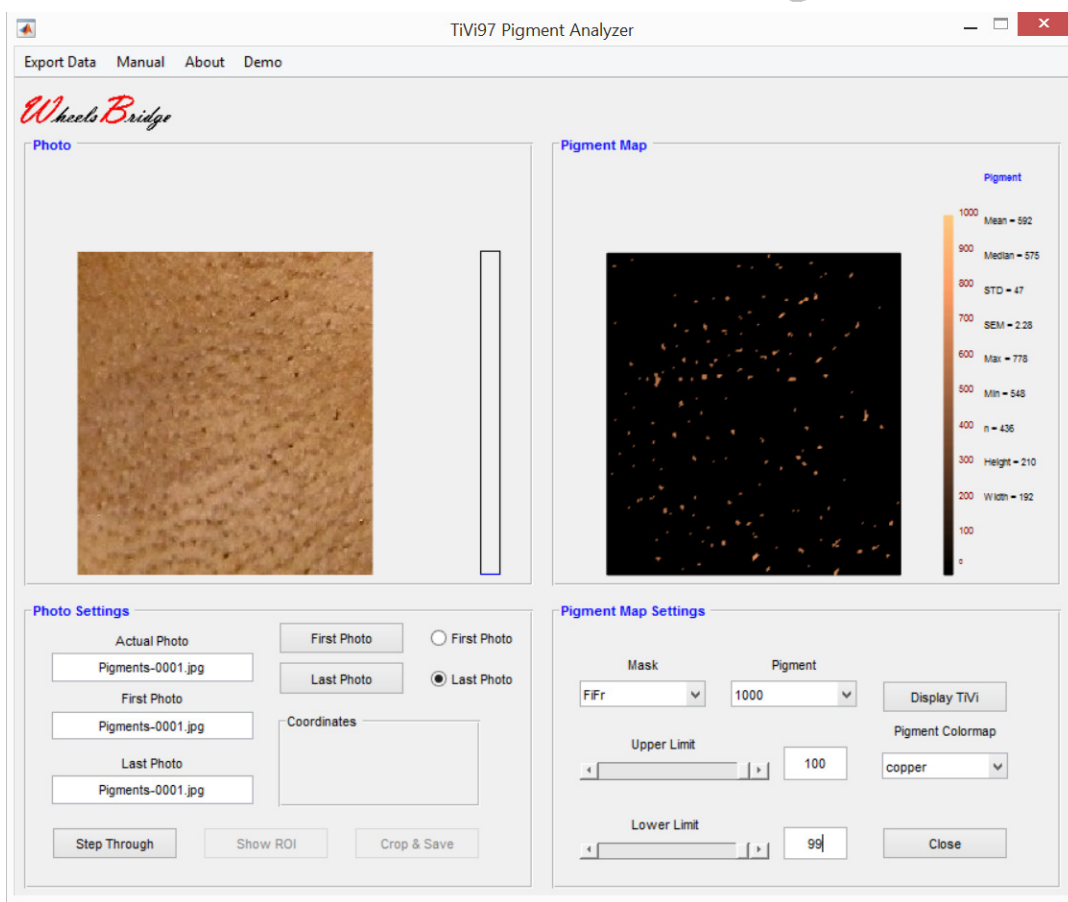




Wheels Bridge



Pigment Analyzer TiVi97 User Manual

User Manual 3. 3
Version 3.3
February 2019

PIONEERS IN TISSUE VIABILITY IMAGING

Dear Valued Customer!

Welcome to the WheelsBridge TiVi97Pigment Analyzer intended for automatic analysis of skin pigmentation. The TiVi97 Pigment Analyzer was designed especially for observer-independent analysis of skin pigmentation in association with skin testing and evaluation of skin care products.

The TiVi97 Pigment Analyzer utilizes a highly sensitive digital camera equipped with polarization filters making it possible to suppress direct surface reflections from the skin surface. The versatile system software – based on the MATLAB® high performance language for technical computing – allows for rapid and easy capturing and analysis of images. Among the many useful features of the TiVi97 Pigmentation Analyzer software the following are of particular interest:

- *Creates Pigmentation Maps.*
- *Region of Interest analysis.*
- *Batch analysis of photos.*
- *Easy switching between TiVi-mode (displaying skin RBC concentration) and pigmentation mode.*
- *Integrated thresholding features to display skin areas with high or low pigmentation.*
- *Results can be transferred to spreadsheets for further analysis.*

We are convinced that the TiVi97 Pigment Analyzer will be a productive tool in the objective assessment and skin care products designed to influence the pigmentation of the skin.

Thank you for choosing the WheelsBridge TiVi97Pigment Analyzer.

WheelsBridge AB

TiVi97 Pigment Analyzer

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The *Pigment Analyzer* is not registered as a Medical Device. It is intended for research applications only.

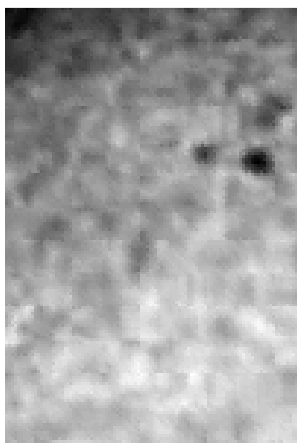
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1. INTRODUCTION

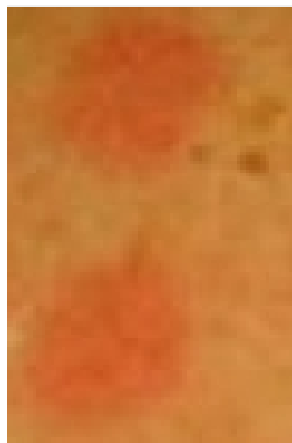
The colour of the human skin is determined by the amount of melanin – a pigment residing primarily in the epidermal layer. Melanin gives the skin a colour ranging from almost black in appearance to white with a pinkish tinge due to the underlying microcirculation of the skin. Skin whitening and removal of pigmented spots are desired target results of modern skin care products and treatment. The *TiVi97 Pigment Analyzer* is a software package that maps the result of such procedures and the effect of topically applied substances by analyzing the pigmentation of the skin with only minimal influence of the underlying microcirculation based on photos captured by polarization spectroscopy camera technology.

2. OPERATING PRINCIPLE

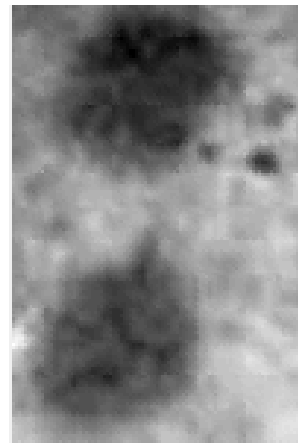
While melanin absorbs light in the red wavelength region to a much higher degree than hemoglobin, the red plane in a photo can be employed to create pigmentation maps. If a photo of the skin including both local erythema produced by topical application of methyl nicotinate and pigmented spots, the red plane (left) maps mainly the pigmented spots, while the green plane (right) maps both the erythema and the pigmented spots:



Red plane

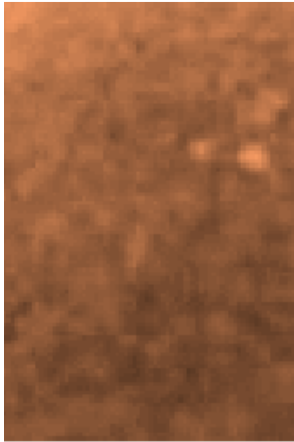


Photo



Green Pane

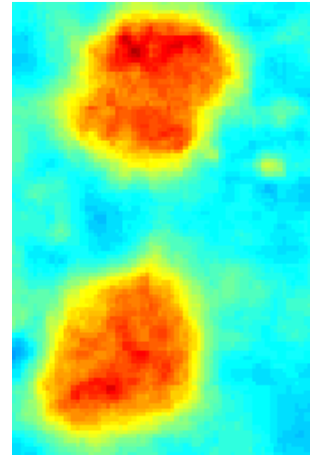
By applying an over-all gain-factor based on the difference between the normalized green plane average value and the red plane average value multiplied by the red plane information pixel by pixels a *Pigmentation Map* can be constructed in which the individual pixel values and colour scale with the degree of local pigmentation (left) independent of the amount of local erythema.



Pigmentation Map



Photo

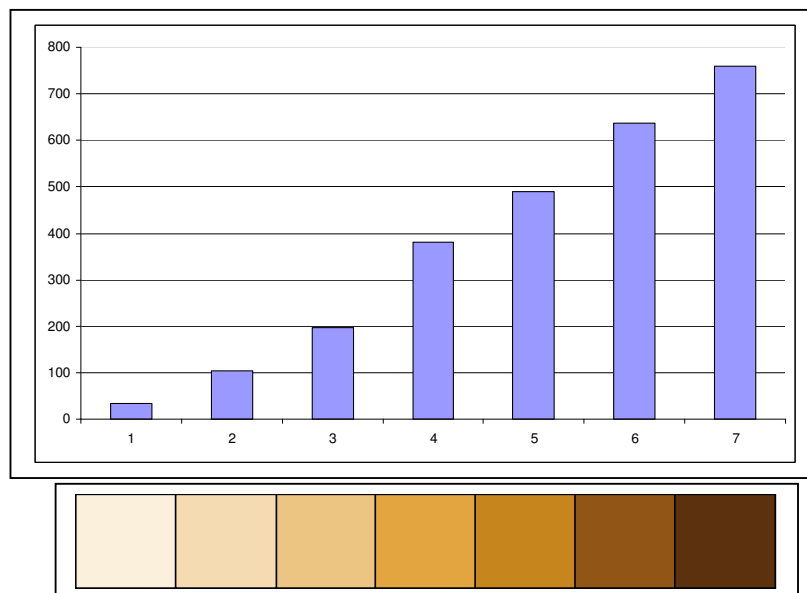


TiVi Map

3. CALIBRATION

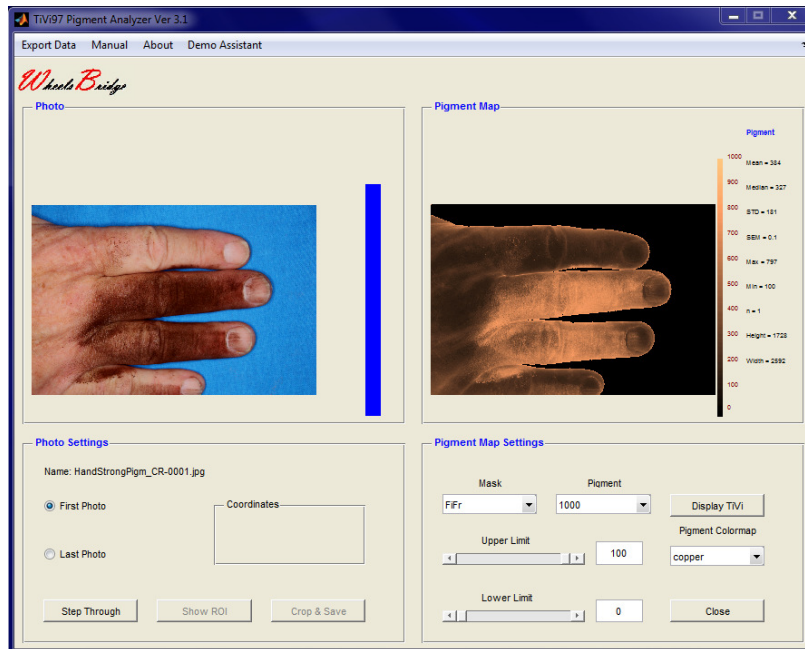
Calibration of the *TiVi97Pigment Analyzer* algorithm was performed by analyzing photos of different colours ranging from white-pinkish (mimicking the colour of Caucasian skin with a low degree of pigmentation) to dark brown (mimicking the colour of Afro-American skin with a high degree of pigmentation).

In the Figure below the calculated pigmentation value is displayed for the different colours analyzed.

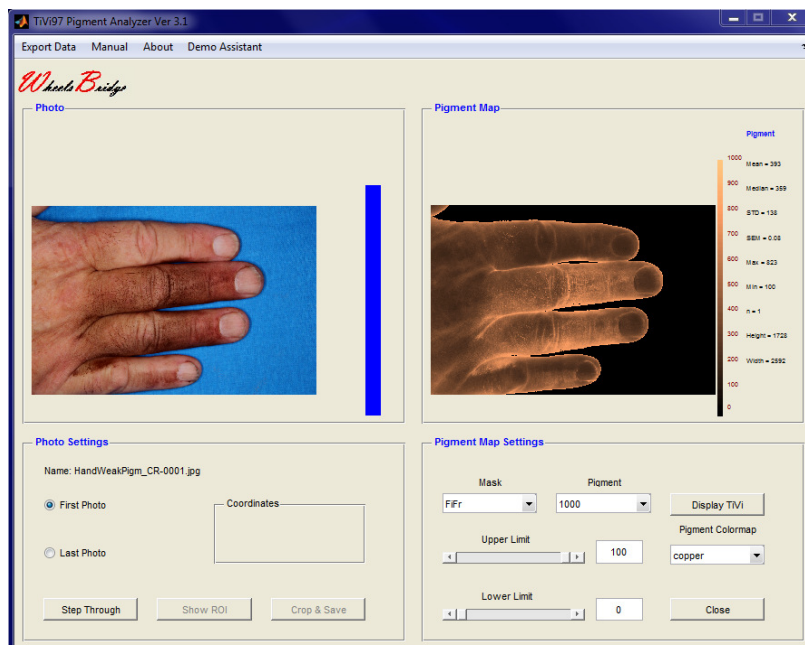


TiVi97 Pigment Analyzer

The Figure below demonstrates the appearance of the *Pigment Map* after applying brown colour-pigment topically on Caucasian skin. Substantially pigmented areas are displayed in lighter colours, while areas less pigmented are displayed in darker colours. The statistics of the *Pigmentation Map* parameters are displayed to the right of the colour bar in the *Pigmentation Map* frame.



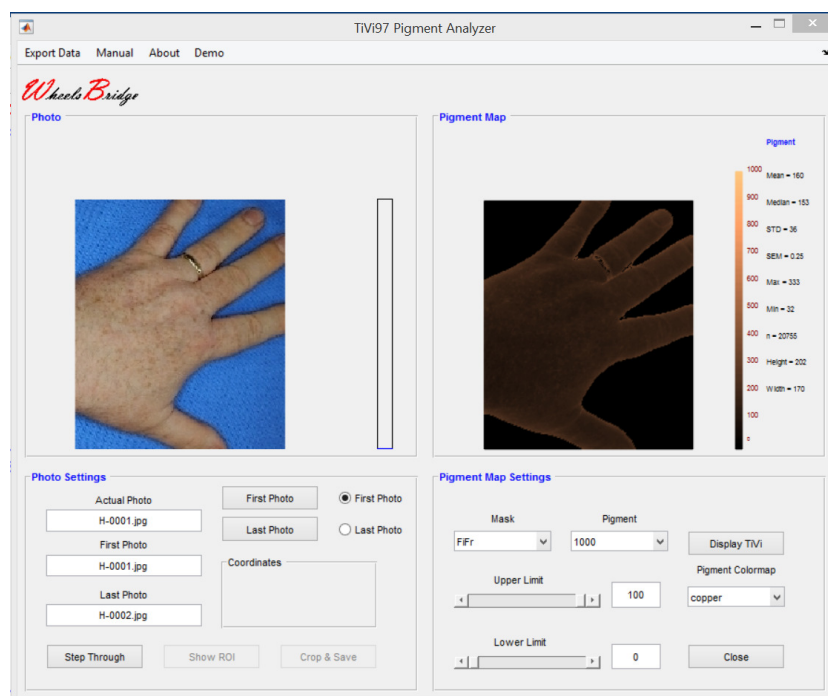
In the Figure below part of the topically applied colour-pigment has been wiped off, giving the affected skin areas a somewhat lighter colour corresponding the less bright areas in the corresponding *Pigmentation Map*.



4. GETTING STARTED

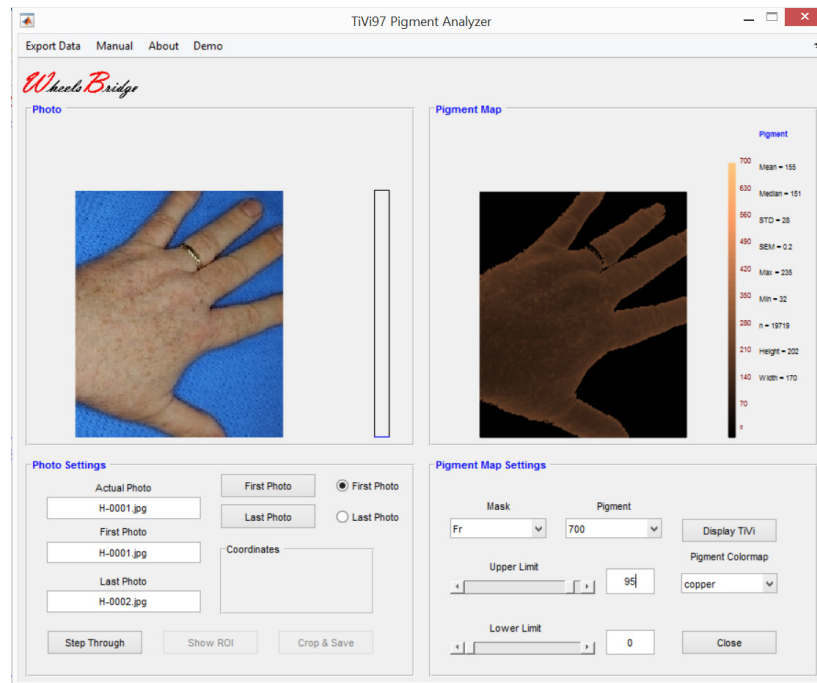
The basic features of the *Pigment Analyzer TiVi97* are probably best explained by way of an example. In the following example it is assumed that the photos *H-0001.jpg* and *H-0002.jpg* have been captured by a camera with polarizing filters and stored in the *TiVi97demonstration* folder. These photos display hands with a different degree of tanning and thus a different degree of skin pigmentation.

1. Open the *TiVi700 Analyzer* window and select the *Pigment Analyzer* from the *Tool Boxes* pull-down menu.
2. Click the **First Photo** button and navigate to the *TiVi97demonstration* folder. Double-click the *H-0001* file. Then check the **First Photo** radio-button.

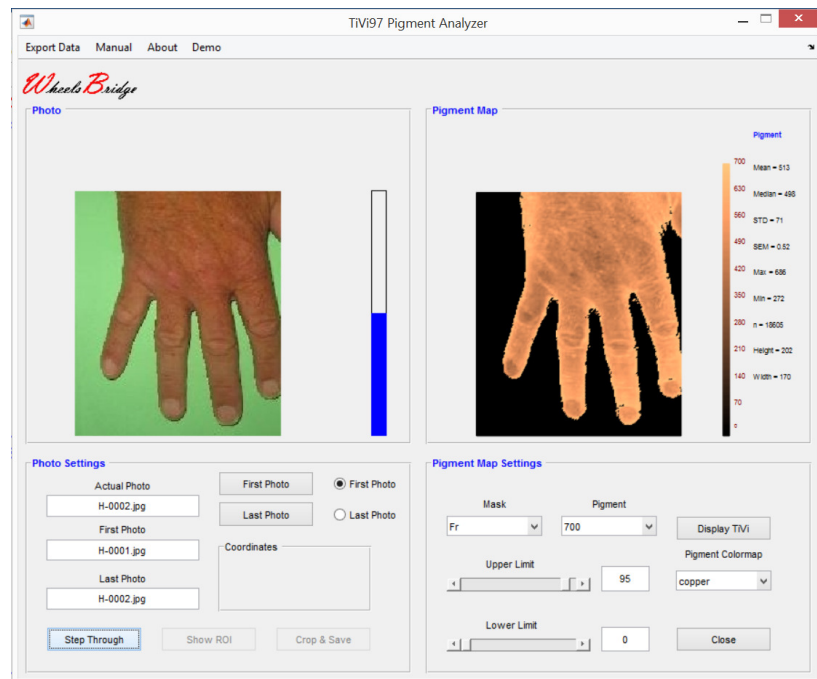


3. Click the **Pigment** pull-down menu and select 700 to change the colour scale of the **Pigment** display.
4. Click the **Mask** pull-down menu and select **Fr** to select *Fraction Mode*.
5. Write “95” in the **Upper Limit** edit box, to display only the lowest 95% of the values (to eliminate influence of the edges). The **Mean Pigmentation Value** now reads 155 A.U.

TiVi97 Pigment Analyzer

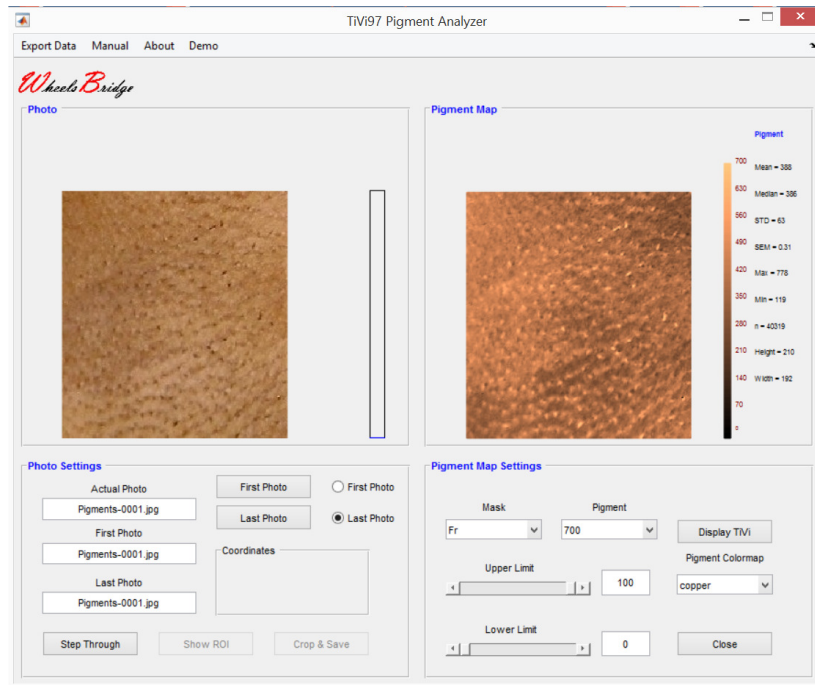


6. Click the **Step Through** button to display Hand-0002. The **Mean Pigmentation Value** now reads 513 A.U.



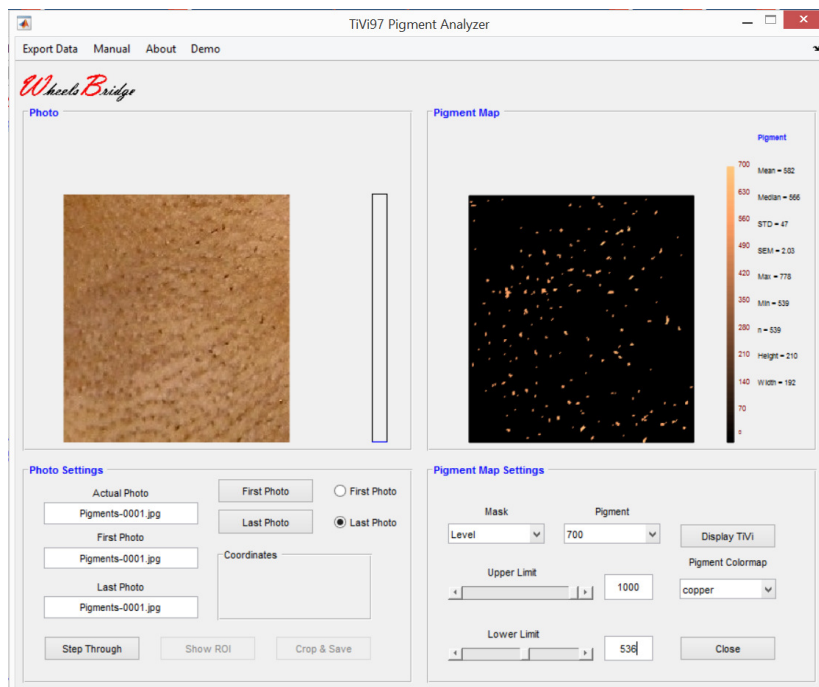
7. Click the **First Photo** button and navigate to the *TiVi97demonstration* folder. Double-click the *Pigments-0001* photo.
8. Move the **Upper Limit** slider to its right-most position.

TiVi97 Pigment Analyzer



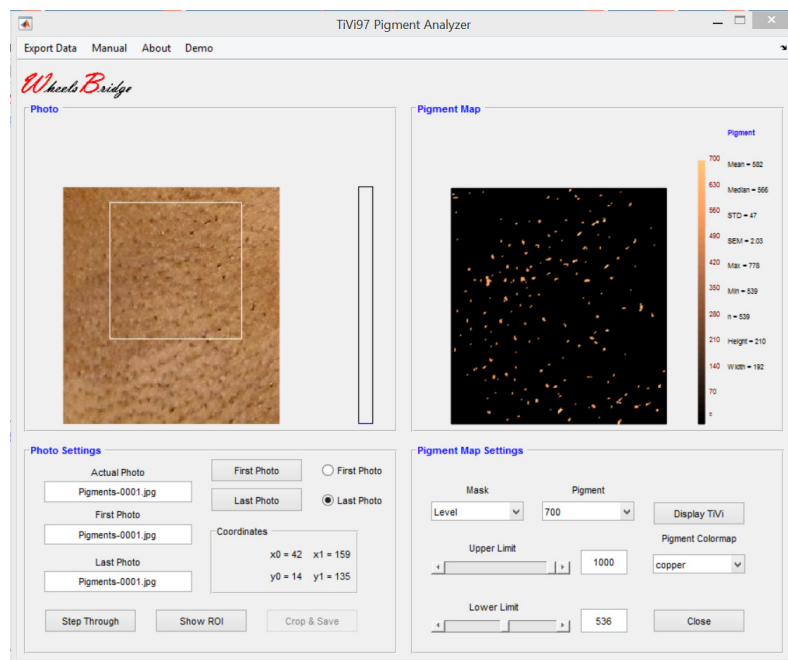
9. Select “Level” in the **Mask** pull-down menu.

10. Drag the **Lower Limit** slider until the associated edit box read “536”.

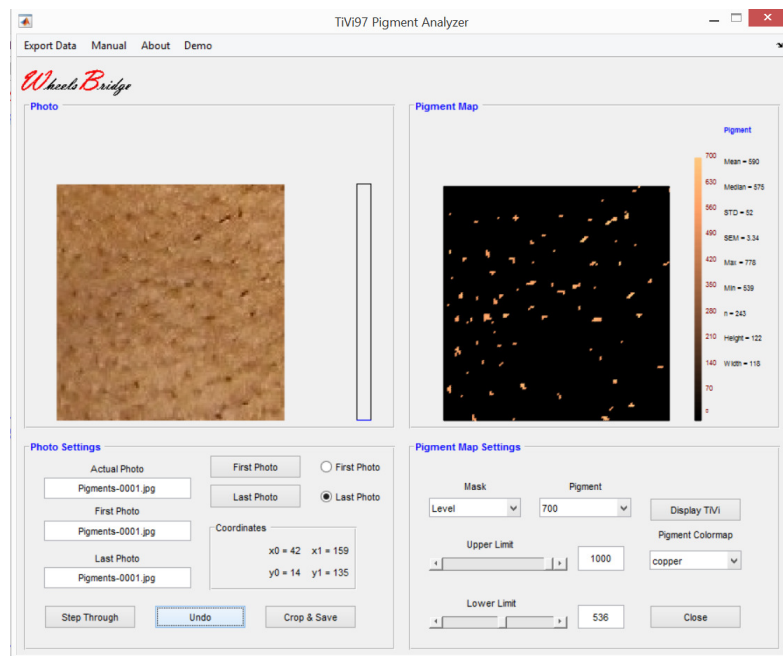


TiVi97 Pigment Analyzer

11. Only pigmentation values between “536” and the maximum value of “778” are now displayed. 539 pixels ($n = 539$) of totally 40320 (Height * Width) have a pigmentation value above 536 (amounting to 1.33% of total area).
12. Draw a **ROI** in the upper centre part of the photo.

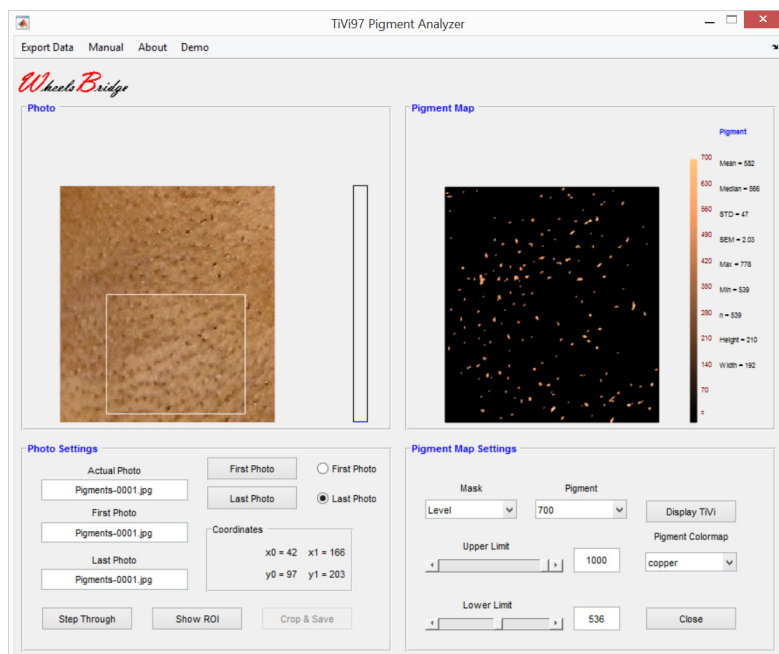


13. Click the **Show ROI** button to display the **ROI** area only.



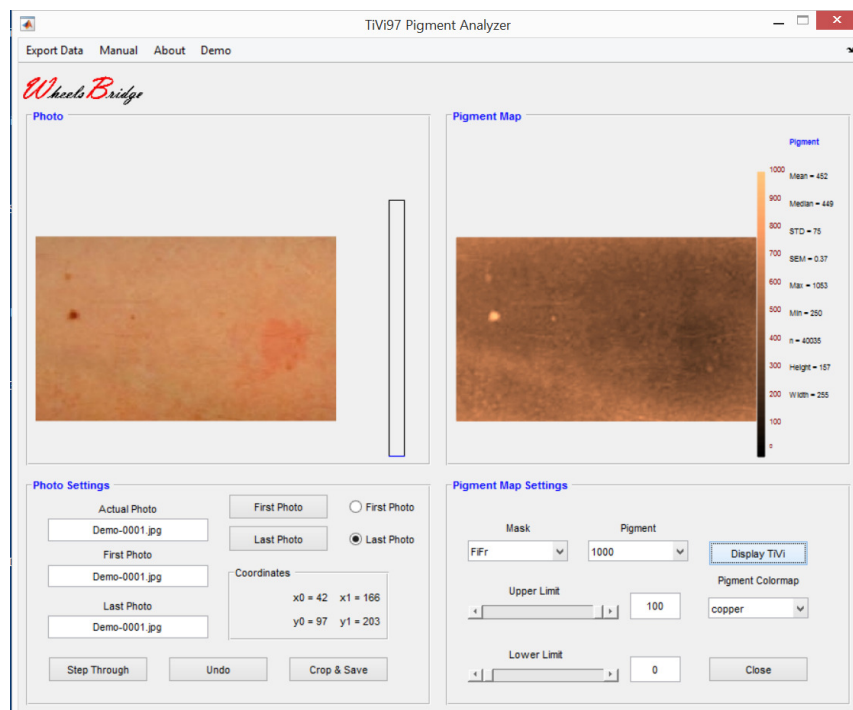
TiVi97 Pigment Analyzer

14. With the same threshold level 171 pixels out of total 9500 (or 1.8% of total area) have values above the set threshold of 536. The *Mean Pigmentation Value* of these pixels is 592 A.U.
15. Click the **Undo** button to return to full view. Draw a new **ROI** covering the lower centre part of the photo.



16. Click the **Show ROI** button to display the selected **ROI** area. Within this area there are 176 pixels (or 1.38% of total area) that have a value above the selected threshold of 536. The *Main Pigmentation Value* of these pixels is 579 A.U.
17. Click the **First Photo** and navigate to the *TiTi97demonstration* folder. Double-click the *Demo-0001* photo.
18. Drag the **Lower Limit** slider to its left-most position. Set the **Mask** to Fr. The *TiVi97 Pigment Analyzer* window should look like:

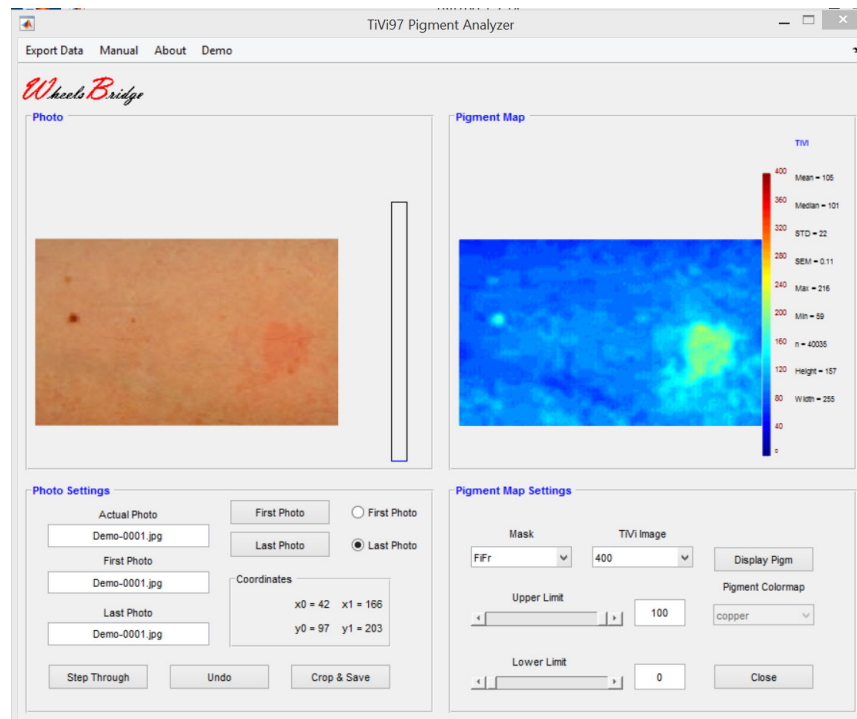
TiVi97 Pigment Analyzer



19. Place the mouse pointer inside the *Pigmentation Map* and move it towards the pigmented spot in the left part of the map. The **Pigmentation Value** at the actual spot is continuously displayed at the bottom of the **Pigmentaion Data** column as the mouse pointer is moved. The **Pigmentation Value** inside the spot is typically in the order of 980 – 990 A.U., while values outside the spot are considerably lower.

20. Set **Mask** to **FiFr**, the **Upper** and **Lower Limit** slider to their right-most and left-most positions respectively. Set **Piment** to 1000. Click the **Display TiVi** button to display the *TiVi* map. Set The **TiVi Image** colour-scale pull-down menu to 400.

TiVi97 Pigment Analyzer



21. Click the Close button to close **the Pigment Analyzer** window.

22. This concludes the **GETTING STARTED** section.

5. DETAILED DESCRIPTION

When the *Pigment Analyzer TiVi97* is started and a photo is uploaded, the photo is displayed in the *Photo* panel and the corresponding pigmentation image in the *Pigmentation Map* panel.

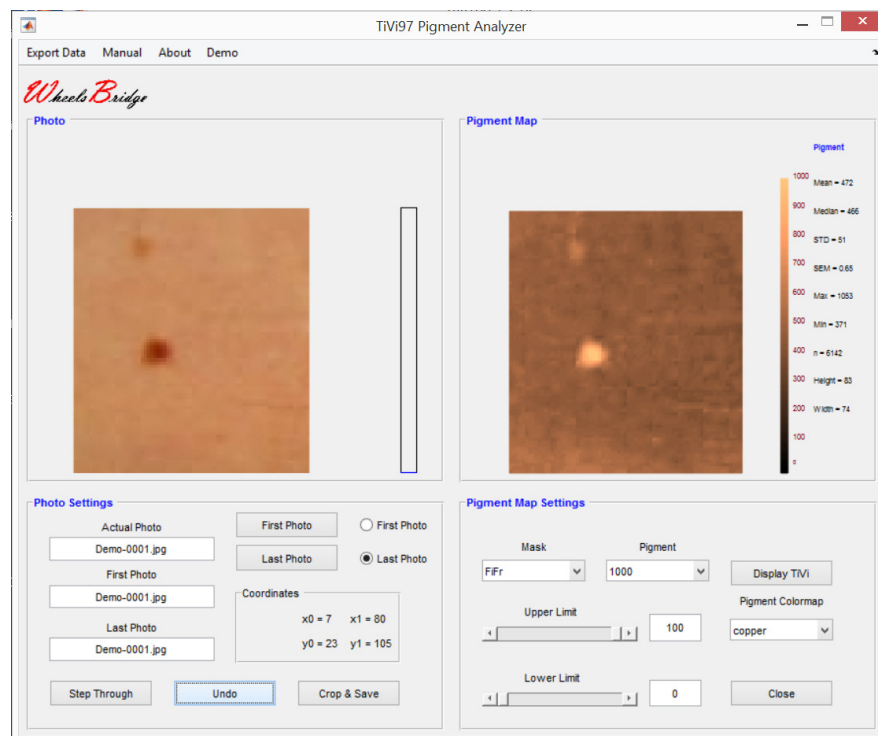


Photo Settings frame:

1. **First Photo** button – to select the first photo from file.
2. **Last Photo** button – to select the last Photo from file.
3. **Show First Photo** radio-button – to display the first photo in the sequence.
4. **Show Last Photo** radio-button – to display the last photo in the sequence.
5. **Actual Photo** edit box - displays the name of the actual photo.
6. **First Photo** edit box - displays the name of the first photo.
7. **Last Photo** edit box - displays the name of the last photo.
8. **Step Through** – click to step through the sequence of photos.
9. **Show ROI** – displays a zoomed-in version of the **ROI** area drawn.

10. **Crop & Save** – to save the selected ROI area as a separate jpg-file.
11. **Coordinates frame:** - displays the actual coordinates when the mouse pointer is moved over the photo area. When a **ROI** area is drawn, the upper left and lower right corner coordinates are displayed.

Pigment Map Settings frame:

1. **Mask** pull-down menu – to select mode of thresholding.
 - a. **FiFr (Fixed Fraction)** – applies the fraction and mask selected for the actual image (with the threshold controls) on all images in the sequence.
 - b. **Fr (Fraction)** – calculates a new (fraction) mask for each individual image.
 - c. **Fi% (Fixed Percentage)** - applies the percentage of max value and mask selected for the actual image (with the threshold controls) on all images in the sequence.
 - d. **% (Percentage)** – calculates a new mask based on percentage of mask value for each individual image.
 - e. **Level** – Applies a fixed set threshold value to create individual masks for each image in the sequence.
2. **Upper Limit slider** – to set the upper limit threshold.
3. **Upper Limit edit box** – to set and display the upper limit threshold.
4. **Lower Limit slider** – to set the lower limit threshold.
5. **Lower Limit edit box** – to set and display the lower limit threshold.
6. **Pigment** pull-down menu – to set the **Pigment Map** colour scale.
7. **TiVi** pull-down menu – to set the **TiVi Map** colour scale.
8. **Display TiVi / Pigm** button – to display either the **Pigmentation Map** or the **TiVi Map**.
9. **Pigment Colourmap** – to select a colour map for the **Pigmentation Map**.
10. **Close button** – to close the **Pigment Analyzer** window.

Pigment Data

1. **Mean** – Pigmentation mean value (A.U.) within selected area.
2. **Median** – Pigmentation median value (A.U.) within selected area.
3. **STD** – Pigmentation standard deviation value (A.U.) within selected area.
4. **SEM** – Pigmentation standard error of the mean value (A.U.) within selected area.
5. **Max** – Pigmentation max value (A.U.) within selected area.
6. **Min** – Pigmentation min value (A.U.) within selected area.
7. **n** – the number of pixels above set threshold within selected area.
8. **Height** – height in pixels of displayed image.
9. **Width** – width in pixels of displayed image.
10. **Pigm** – local **Pigmentation Value** (A.U.)

Pull-down menus

1. **Export data** – to export data to an Excel ® spreadsheet.
2. **Manual** – to show the on-line manual.
3. **About** – displays the About-box.
4. **Demo Assistant** – to display the demo assistant.

