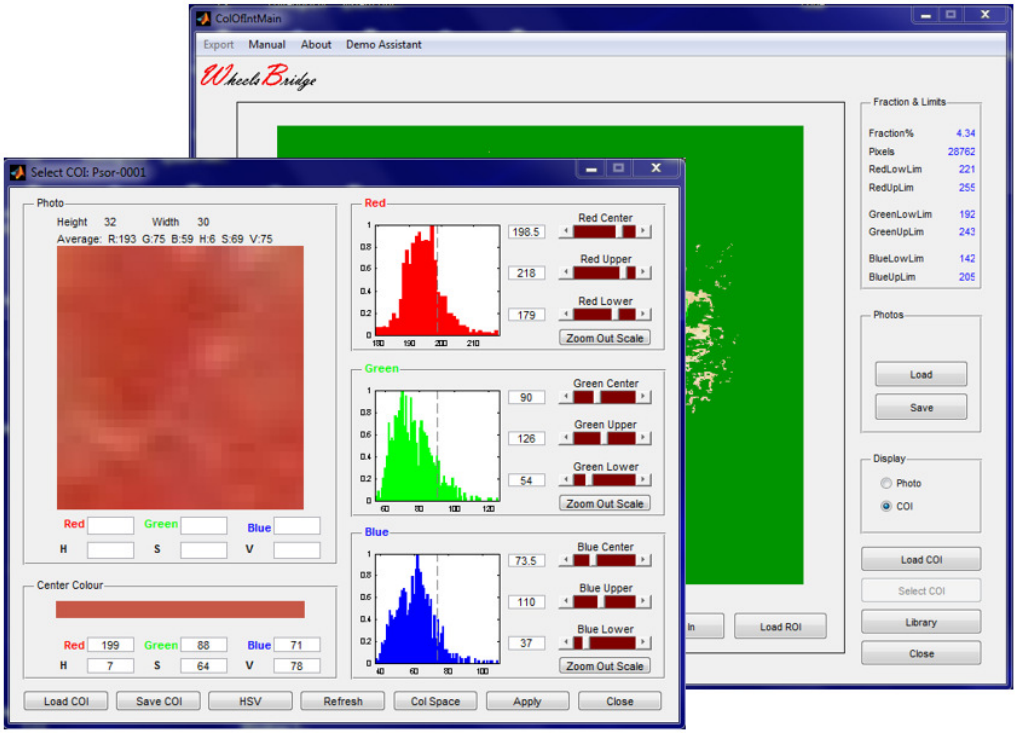
WheelsBridge



Skin Colour Tracker TiVi70
User Manual

User Manual 3.2
Version 3.2
February 2019

PIONEERS IN TISSUE VIABILITY IMAGING

Dear Valued Customer!

Welcome to the WheelsBridge Skin Colour Tracker TiVi70 system designed for automatic analysis of spatial and temporal variations in skin colour. The Skin Colour Tracker was designed especially for observer-independent analysis of changes in skin colour in association with skin diseases and other conditions that may result in alterations in skin optical properties.

The Skin Colour Tracker 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 Skin Colour Tracker software the following are particularly helpful in the evaluation of spatial or temporal variations in skin colour:

- *Automatic capturing of photos.*
- *Zoom-in features to display details of images.*
- *User definition of Colours of Interest (COI).*
- *Inspection of COI in the RGB and HSV Colour space model.*
- *Application of COI to entire images and sequences of images.*
- *Uploading of up to eight images to display consecutive changes in skin colour.*
- *Integrated trend analysis.*
- *Export of data to Excel® spreadsheet.*
- *Online manual*

We are convinced that the Skin Colour Tracker will be a helpful tool in the assessment and follow-up of spatial variations in skin colour and in changes in skin colour over time.

Thank you for choosing the WheelsBridge Skin Colour Tracker TiVi70.

WheelsBridge AB

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The *Skin Colour Tracker* is patented and/or patents are pending in several countries.

The *Skin Colour Tracker* is not registered as a Medical Device. It is intended for research applications only.

WheelsBridge is a registered trade mark.

1. INTRODUCTION

The colour of the skin changes over time in many diseases and conditions and can thus be a useful indicator for assessment of the development and progression of skin disease or a healing process. What is generally referred to as skin colour is the spectral content of backscattered light following illumination by a light source. Consequently, the skin colour observed is not only dependent on the optical properties of the skin, but also on the spectral signature of the illuminating light, i.e. the colour perceived is dependent on the spectral signature of the illuminating light source. If a digital camera is used to capture a photo of the skin, the spectral sensitivity of the photo-detector array further influences the colour of the photos recorded. Consequently, skin colour can not be regarded as an absolute quantity. Changes in the spectral content of the diffusely backscattered light from the skin under illumination by a light source with a fixed spectral signature, however, carries useful information about changing skin conditions.

By way of polarization camera technology, the *Skin Colour Tracker TiVi70* captures photos of the skin and displays these photos in a user interface. The user then selects a region of interest (**ROI** - a region with a specific set of colours). By analyzing the spectral content of the selected **ROI** in this photo, and by further limiting the spectral content of the actual **ROI,** selection of a range of **Colours Of Interest** (**COI**) can be made. The **COI** defines a mask of selected colours that is applied to the actual photo or any other sequence of photos loaded into the program. The **COI** technically constitutes a volume in the **RGB** or **HSV** colour model space and conversion between the two colour models can be made. The **RGB** colour model determines the amount of **R**ed, **G**reen and **B**lue colour in a photo and any picture element in the photo is defined by a triplet of integer values (between 0 and 255) that determines the actual colour. The **HSV** colour model also describes the colour of an individual picture element in terms of a triplet (**H**ue, **S**aturation and **V**alue). The **H**ue defines the colour (throughout the visible spectrum), while **S**aturation defines how saturated a colour is and **V**alue defines how light/dark a specific colour is. When a photo is described in either the **RGB** or the **HSV** colour space model, it is totally defined by a unique set of triplets - each triplet representing a specific pixel in the photo. Conversion between the two colour models can be made automatically. More information about the two colour models can be found at e.g. http://en.wikipedia.org/wiki/RGB_color_model and http://en.wikipedia.org/wiki/HSV_color_space.

The intended use of the *Skin Colour Tracker TiVi70* is to map colours of specific colour space volumes in research applications. It is not yet approved for the diagnosis and treatment of disease.

2. OPEARATING PRINCIPLE

The *Skin Colour Tracker* operates in the following way:

1. A sequence of photos of the same skin site is recoded at different points in time.

2. A single photo of the sequence is uploaded to the user interface.

3. A region of interest (**ROI**) in this photo is defined by use of the mouse, representing the colours of interest (**COI**).

4. This **ROI** is exported to the **Select COI** window, in which the selected **COI** can be further defined using the **RGB** or the **HSV** colour model. This fine-tuned **COI** is represented by a mask generated in the **ROI**.

5. The **COI**-mask is exported back to the main window where it is applied to the entire photo. In this photo, only colours represented by the **COI**-mask are displayed and accounted for in the further statistical analysis.

6. An entire sequence of photos, to which this **COI-mask** is applied, is loaded to the *Skin Colour Tracker* **Library** page. The triplets inside the colour volume defined by the **COI**-mask are displayed in each photo uploaded to the library.

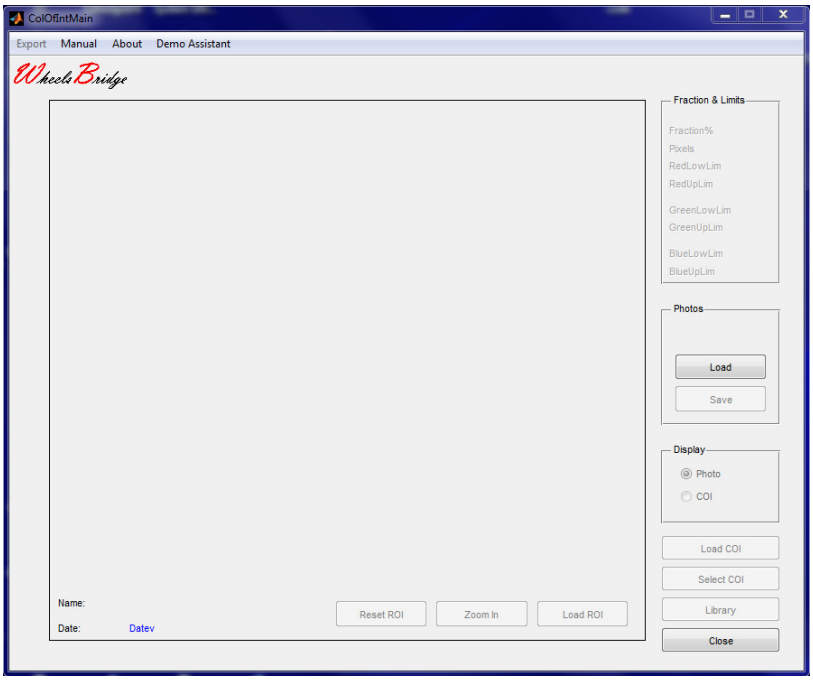
7. By use of the integrated **Trend Analyze**r, the percentage area of the actual skin sites that possesses colours defined by the **COI-mask** is displayed, thereby making it possible to visualize changes in selected colour regions as defined by the **CO**I-mask over time.

In the **GETTING STARTED** section these features are further explained by way of an example

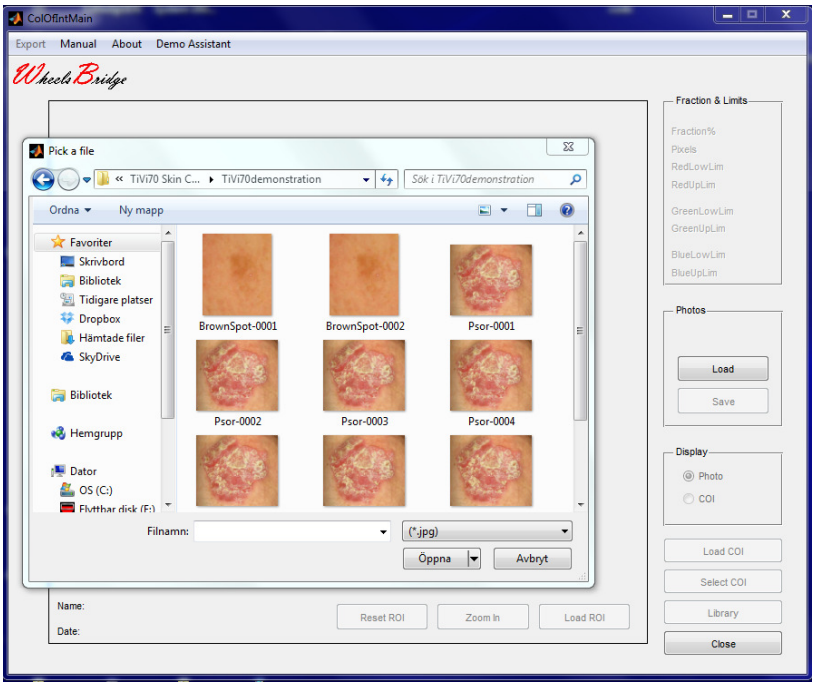
3. GETTING STARTED

The basic features of the *Skin Colour Tracker TiVi70* are probably best explained by way of an example. In the following example it is assumed that the photos **Psor-0001** to **Psor-0008** have been captured and stored in the folder **TiVi70demonstration**. These photos simulate minute changes in a psoriasis plaque over time. The task is to analyze how the extension of areas with inflammation (red tissue) and scaling (white tissue) changes from the first to the last photo in the sequence. Such assessments form an integral part of PASI (Psoriasis Assessment Severity Index) calculations which are frequently used in clinical routines. The precise colours of interest are defined by the user by means of the **Select COI** window.

1. Open the *Skin Colour Tracker* main window.



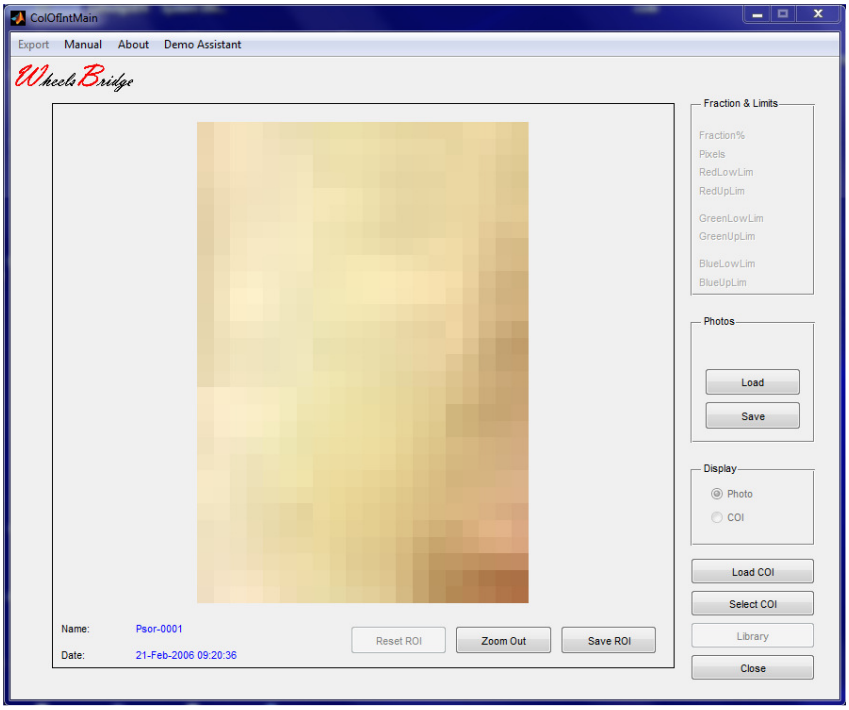
2. In the *Skin Colour Tracker* **Main Window**, click the **Load** button. Navigate your way to the **TiVi70demonstration** folder. Double-click the **Psor-0001** file.



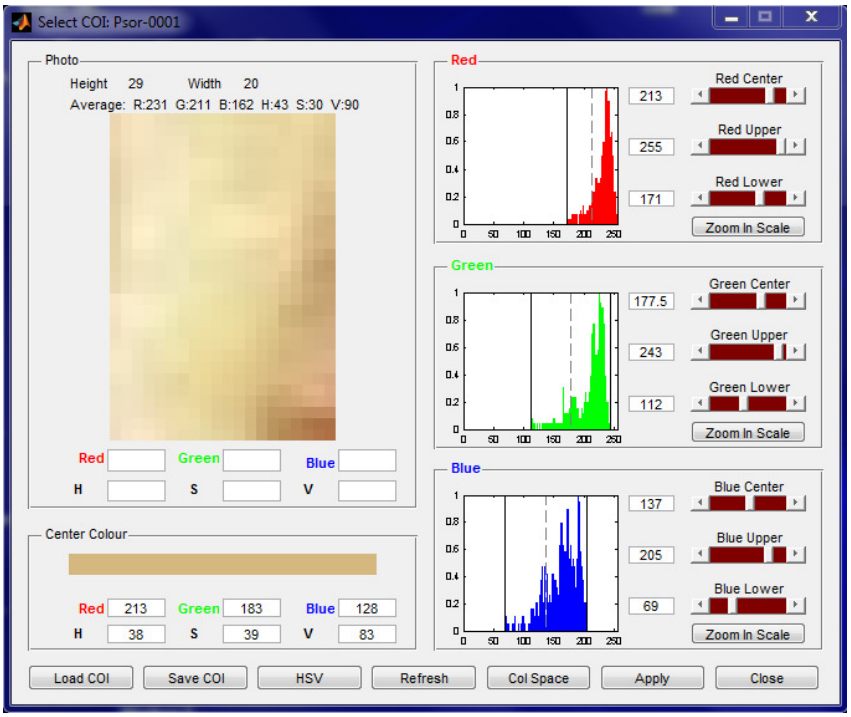
3. The *Skin Colour Tracker* main window should now look like:

4. Position the mouse pointer at the top left corner of the **ROI** to be drawn (a white area representing scaling). Press the left mouse button and drag the mouse pointer to the lower right position of the **ROI** to be drawn. Release the left mouse button. The *Skin Colour Tracker* main window should now look like:

5. Click the **Zoom In** button to display the **ROI** selected. The *Skin Colour Tracker* main window should now look like:

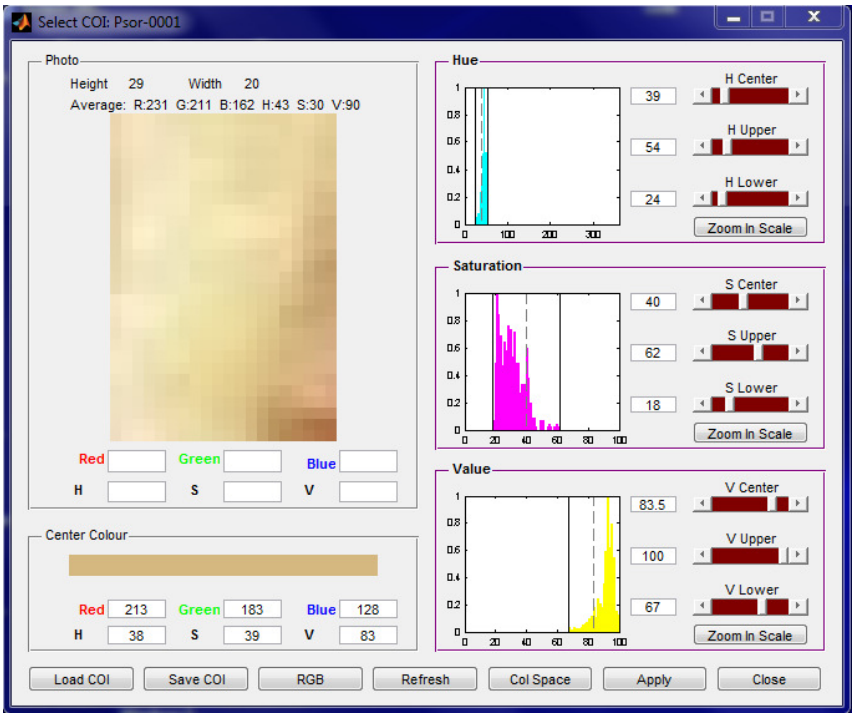


6. This zoomed-in image contains the spectrum of white colours representing scaling tissue, but also some other colours not characteristic for scaling. This part of the colour volume can be eliminated from the **Colours of Interest** by use of the **Select COI** window. Click the **Select COI** button to open the **Select COI** window.



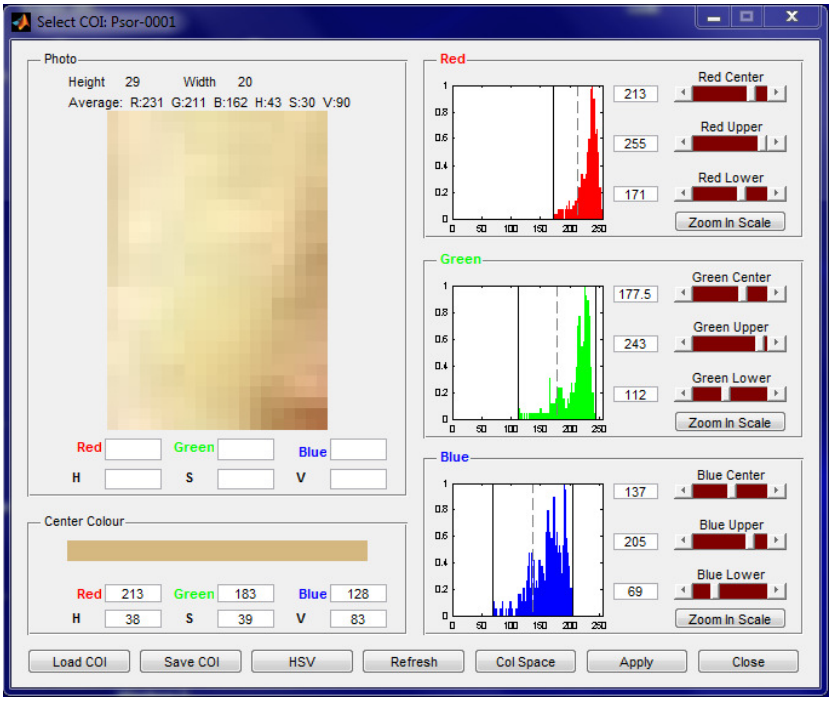
7. In the **Select COI** window the **ROI** is displayed in the **Photo** panel. In the **Red**, **Green** and **Blue** panels the distributions of the values in the three **RGB** colour planes are displayed. The vertical solid lines in the diagram indicate the minimum and maximum limits of each colour while the dotted lines indicate the center values. In the **Center Colour** panel, the center colour is displayed. In the **Edit** boxes below the center colour display, the corresponding **Red, Green** and **Blue** values are shown. The associated **HSV** center values are displayed in the **Edit** boxes below the **RGB**-values.

8. Click the **HSV** button to display the colour distributions in the **HSV** colour model. The **H, S** and **V** value distributions are now displayed in their respective panels.

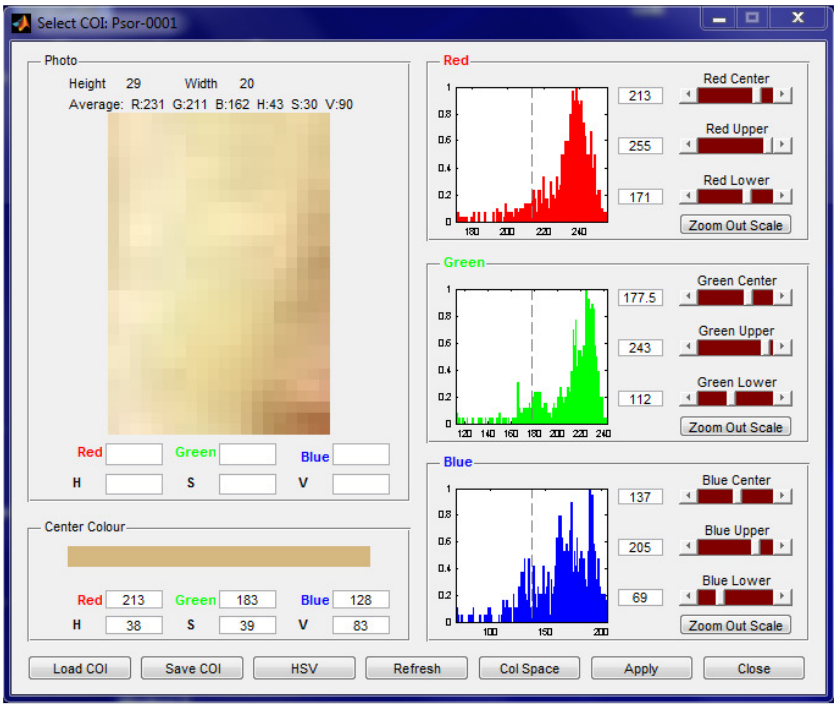


9. Click the same button - now labeled **RGB** - to return to the **RGB** colour model presentation mode.

10. Move the mouse cursor over the photo. The actual picture element **Red, Green** and **Blue** triplet values as well as the **H**, **S** and **V** triplet values are displayed and continuously updated in the **Edit** boxes below the photo.

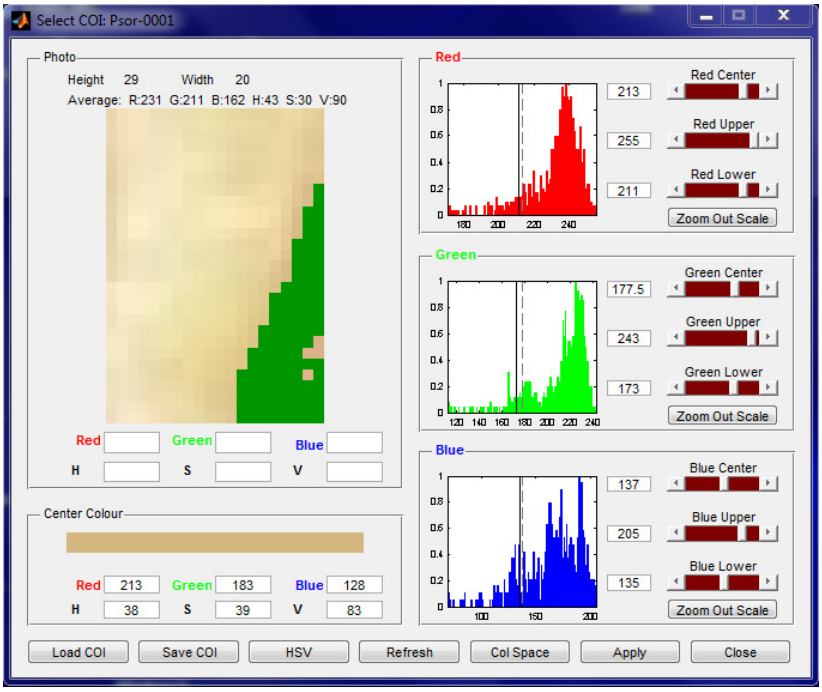


11. Click the **Zoom in Scale** buttons in the **Red, Green** and **Blue** panels respectively to zoom in on the distributions between the **Upper** and **Lower Limits**. The **Select COI** window should now look like:



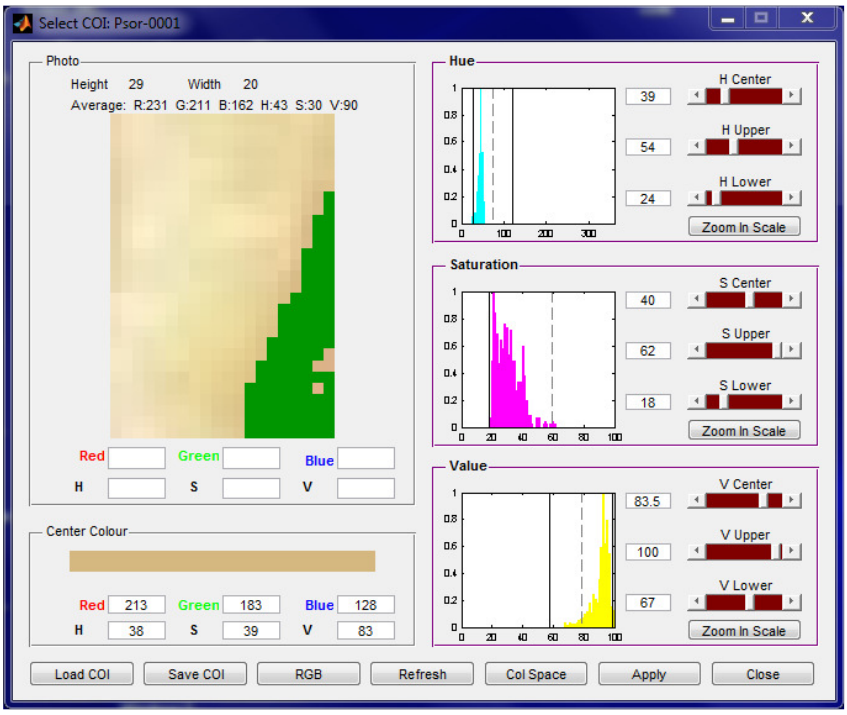
12. To generate a **COI**-mask and further limit the range of colours displayed in the **ROI** to include only white colours**,** successively click the right arrow in the **Red Lower** slider (red **Lower Limit**) until the solid vertical line reaches a position immediately to the

left of the dotted center colour line (setting of these colour limits can also be made by inserting the target colour limit in the associated **Edit** box or by dragging the colour limit vertical line by use of the mouse). Repeat this procedure using the **Green Lower** and **Blue Lower** sliders. The **Select COI** window should now look like:

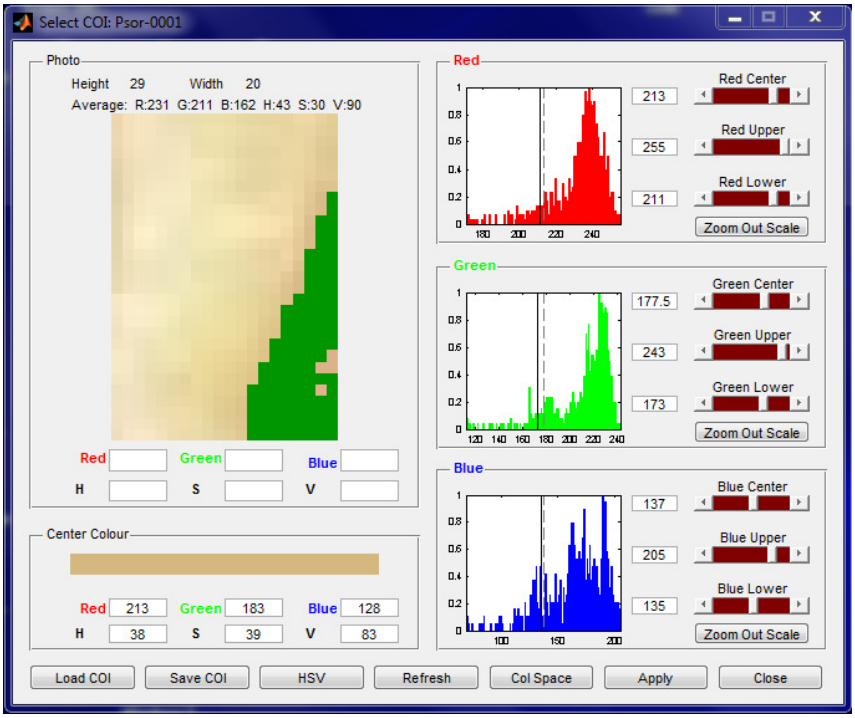


13. The photo now displays colours defined by the settings of the vertical colour limit lines. The green area in the photo corresponds to colours outside the settings. The colour range defined by this mask is denoted **COI**.

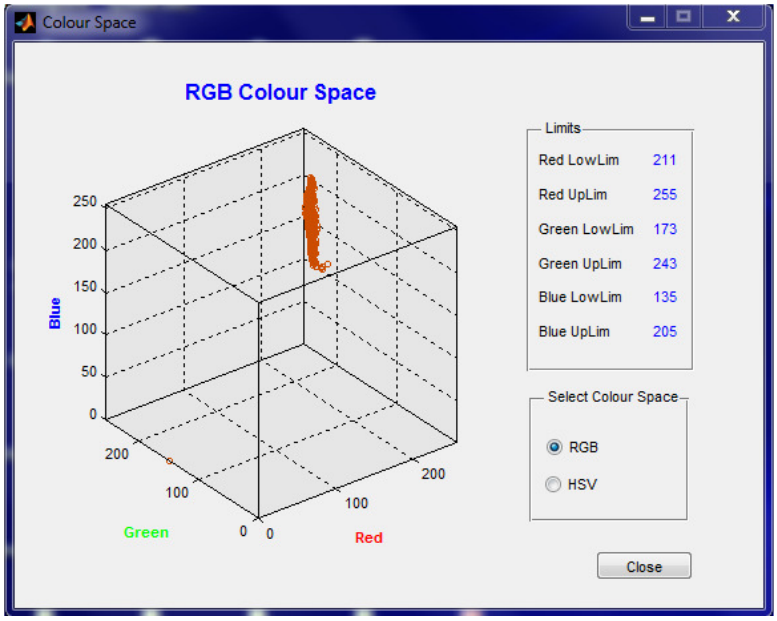
14. Click the **HSV** button to display the mask and the associated colour limit settings in the **HSV** colour model.



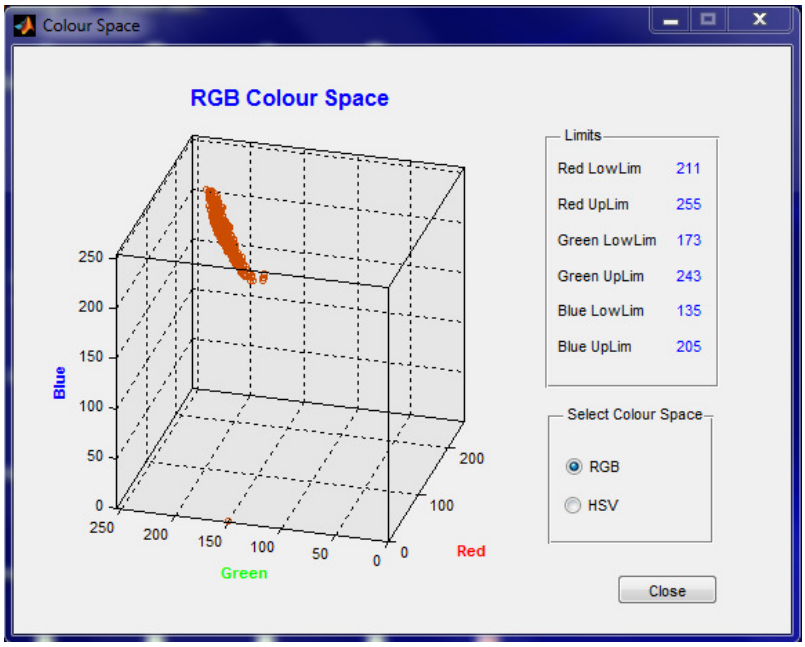
15. Click the **RGB** button to bring the system back to the **RGB** colour model presentation mode.



16. Click the **Col Space** button to open the **Colour Space** window. This window displays how the individual **RGB** triplets of pixels within the **COI** mask are distributed in the **Colour Space** volume.

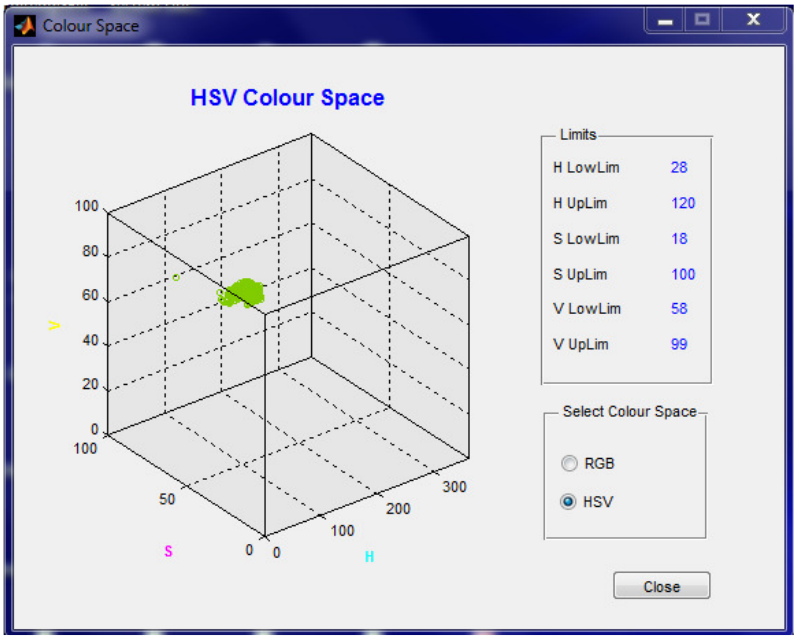


17. Move the **Mouse Pointer** to the centre of the diagram (the pointer changes to circle). Press the left mouse button and move the mouse. The diagram can now be viewed from different angles.

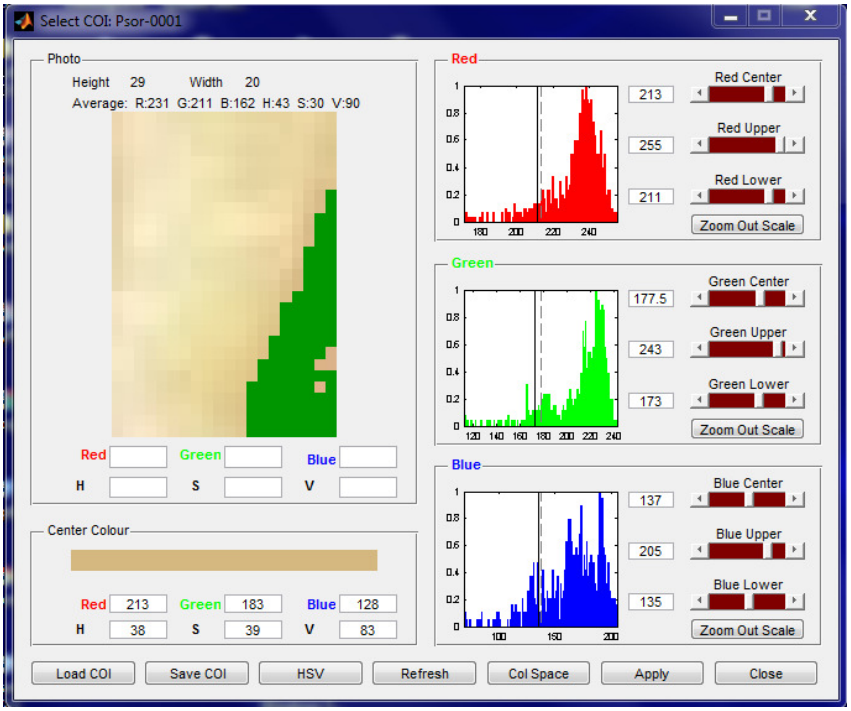


18. Click the **HSV** radio-button to shift to the **HSV Colour Space** view**.** The more uniform the colours within the **COI**-mask are, the more are they confined to a small

volume in the **Colour Space**. The actual **Upper Limits** and **Lower Limits** as set in the **Select COI** window are displayed in the **Limits** panel.



19. Click the **Close** button to close the **Colour Space** window and return to the **Select COI** window.

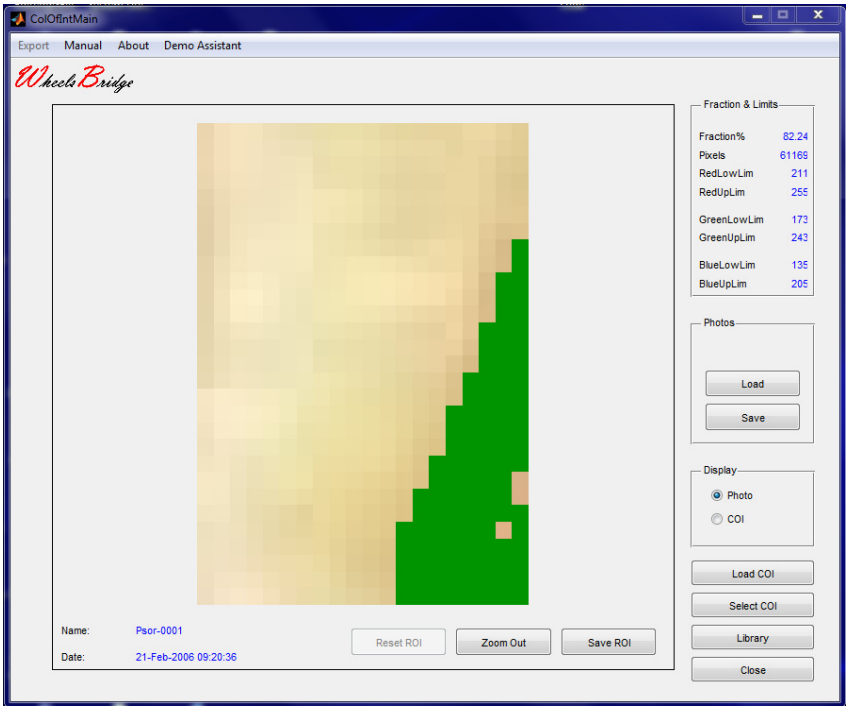


20. Click the **Save COI** button and save the colour limit settings under the name "*MyFirst*", so the actual **COI** - mask can be regenerated at a later session.

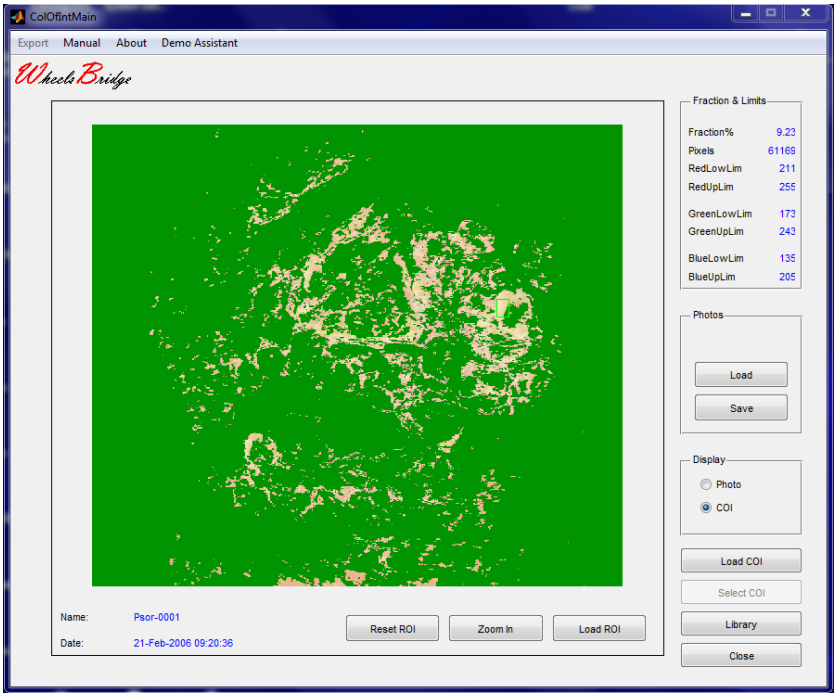
21. Click the **Refresh** button.

22. Click **Load COI** and reload the "*MyFirst*" **COI**.

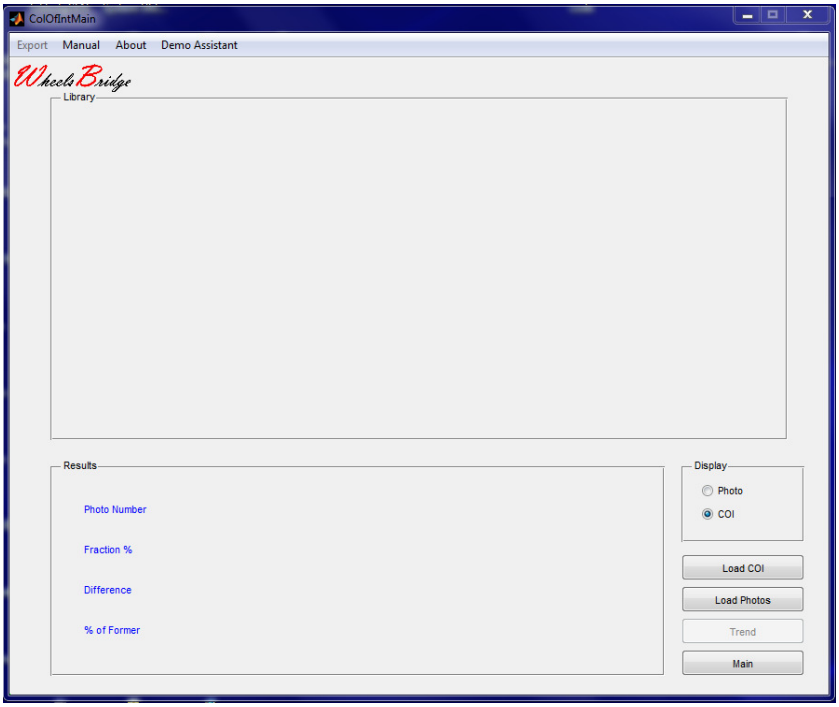
23. Click the **Apply** button to export the colour limit settings back to the *Skin Colour Tracker* main window. The **Select COI** window closes, and the focus is again on the *Skin Colour Tracker* **Main window**, which should look like:



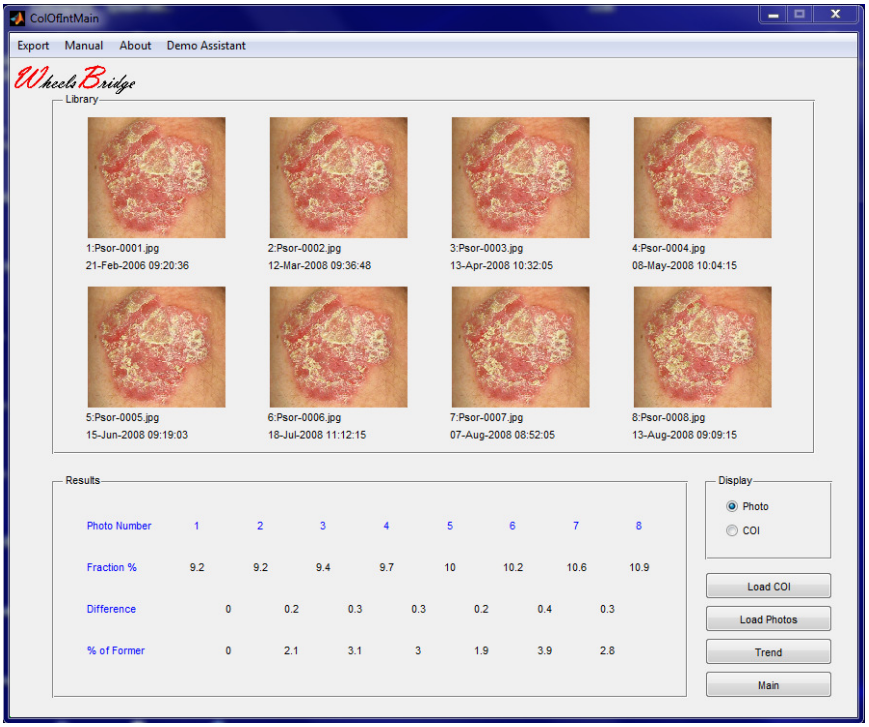
24. In the **Fraction & Limits** panel, the **COI** limits are displayed together with the fraction of displayed tissue in percentage which is occupied by the actual colours of interest in the colour volume space. Click the **Zoom Out** button and then click the **COI**-radio-button to apply the **COI**-mask to the entire photo. Toggle between the pure photo and a photo with superimposed **COI**-mask by using the **Photo** and **COI** radio-buttons. Observed that in **Zoom Out** mode the fraction changes to 9.23 % - i.e. scaling tissue occupies 9.23 % of the entire displayed skin area.



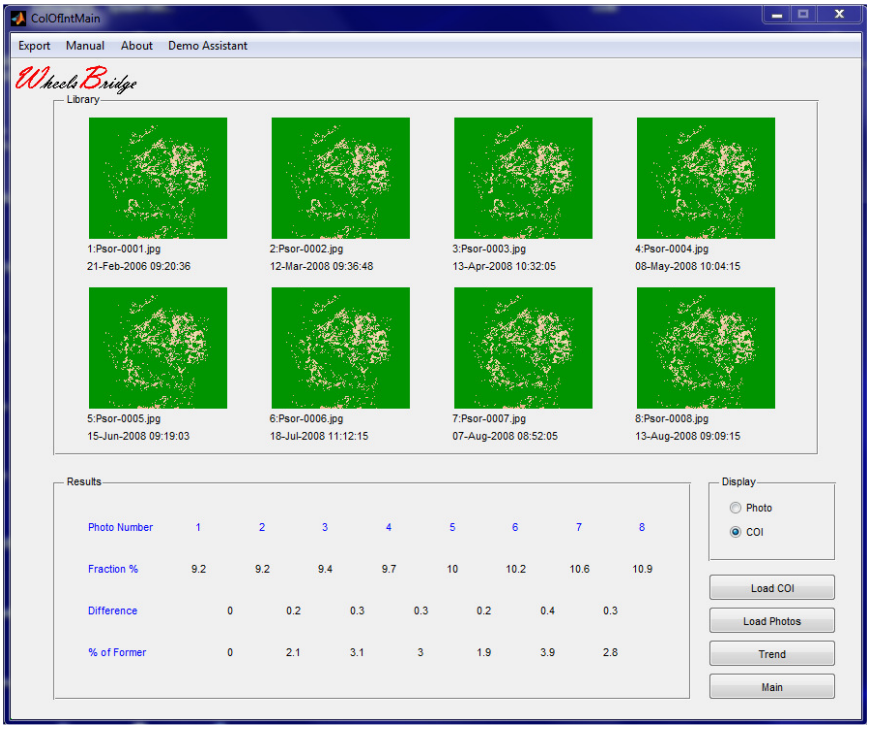
25. Click the **Library** button to switch to the **Library** page in the *Skin Colour Tracker*.



26. Click the **Load Photos** button and select the first photo in the photo sequence to be displayed (**Psor-0001** in the **TiVi70demonstration** folder). Up to eight photos with the same name prefix and consecutive numbers are now uploaded to the library and displayed in the **Library** panel.



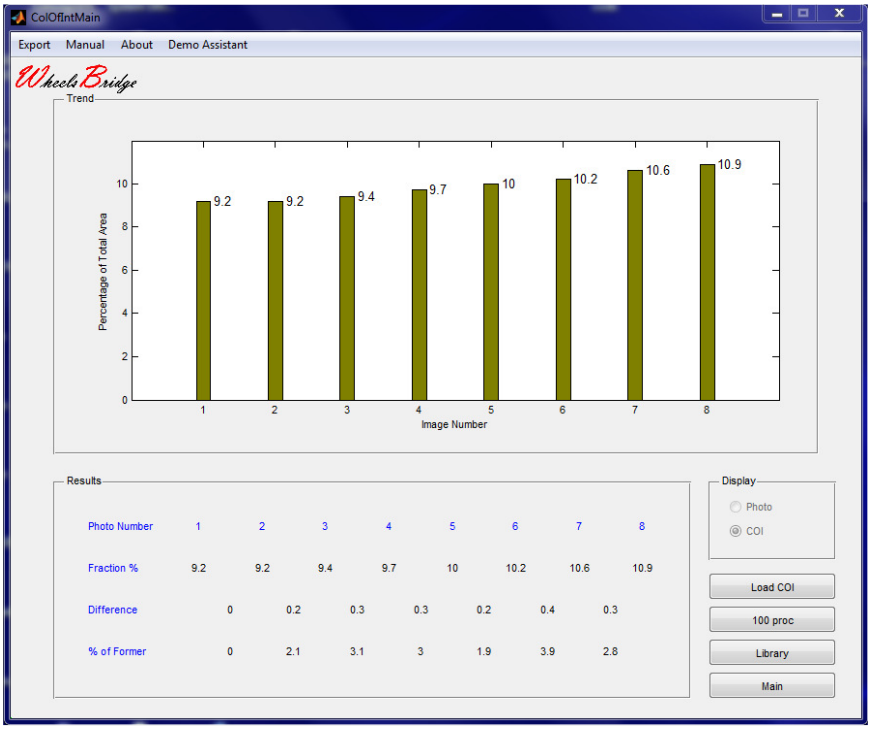
27. Click the **COI** button to display these photos with superimposed **COI**-mask.



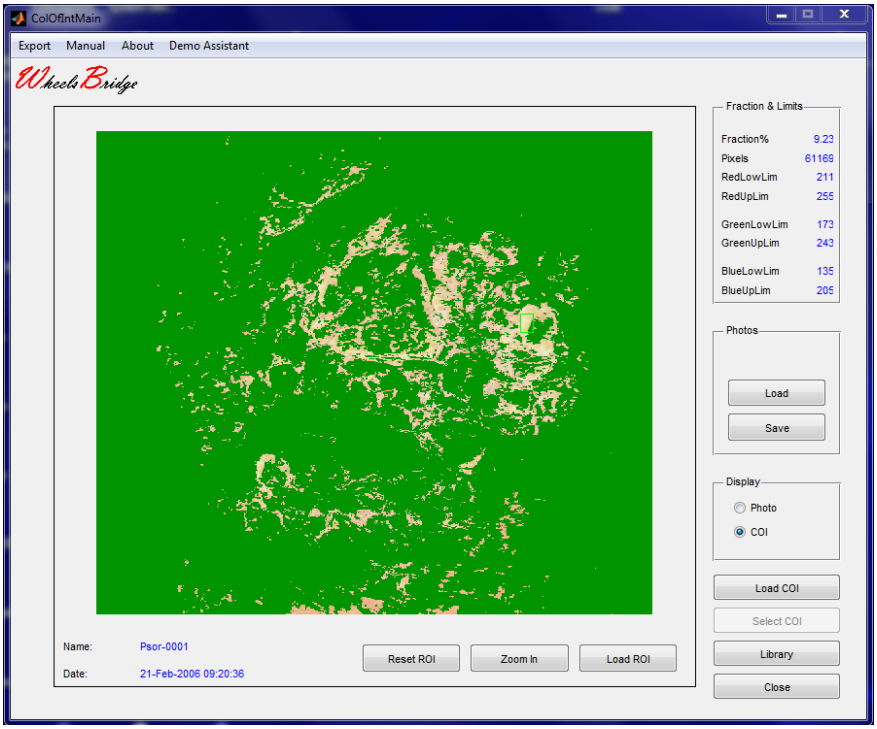
28. In the **Library** panel, the eight uploaded photos are now displayed with superimposed **COI**-masks. In the **Results** panel, the fraction (**Fraction %**) of the entire photos represented by **COI** values, the difference in this percentage from one photo to the

next (**Difference**) and the relative change in percentage (**% of Former**) of the area occupied by the **COI**-masks, are displayed.

29. Click the **Trend** button to display the trend in terms of **Fraction %** in the **Trend** page**.** Click the **Adapt** button to adapt the y-scale. The *Skin Colour Tracker* window should now look like:

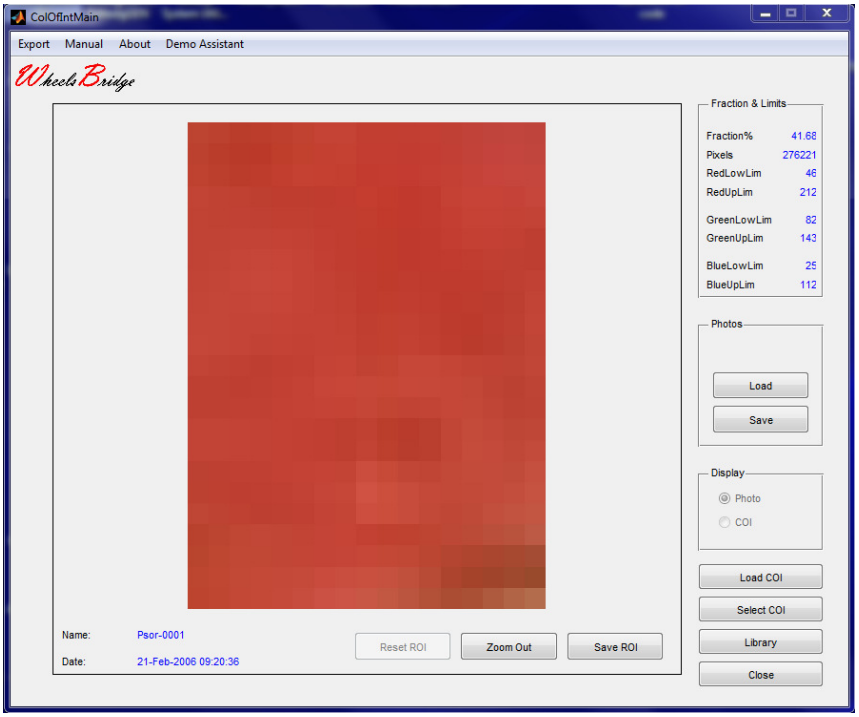


30. The upward trend demonstrates how the extension of areas with scaling increases over time. Click the **Main** button to return to the *Skin Colour Tracker* main window.

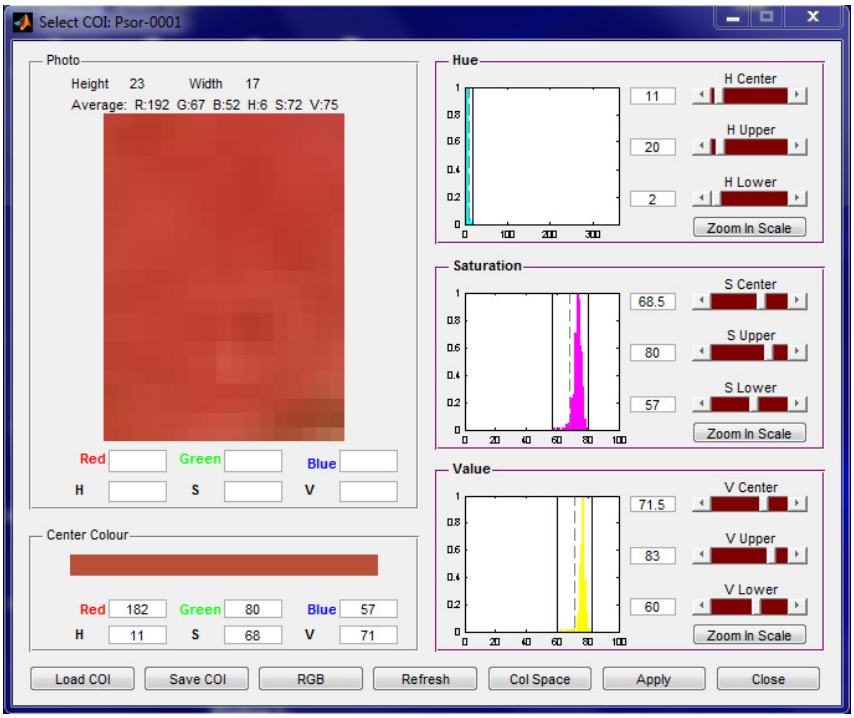


31. Click **Photo** in the **Display** panel to return to the photo mode. Draw a **ROI** in an area with inflammation to demonstrate how the extension of these areas is reduced over time. The window could for instance look like:

32. Click **Zoom In** to display the selected **ROI**.

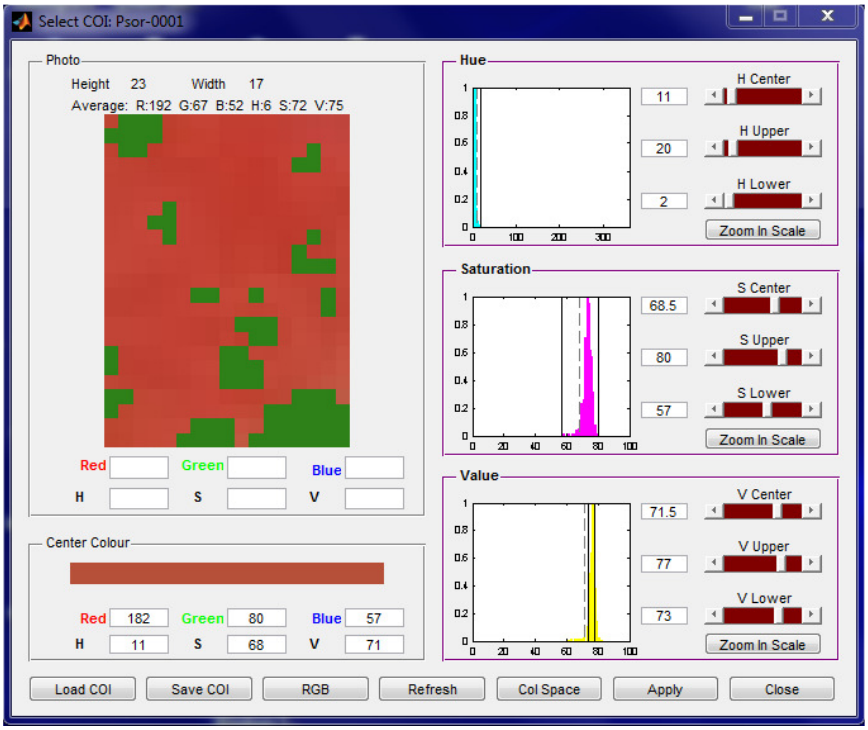


33. Click **Select COI** to open the **Select COI** window and then click the **HSV** button.

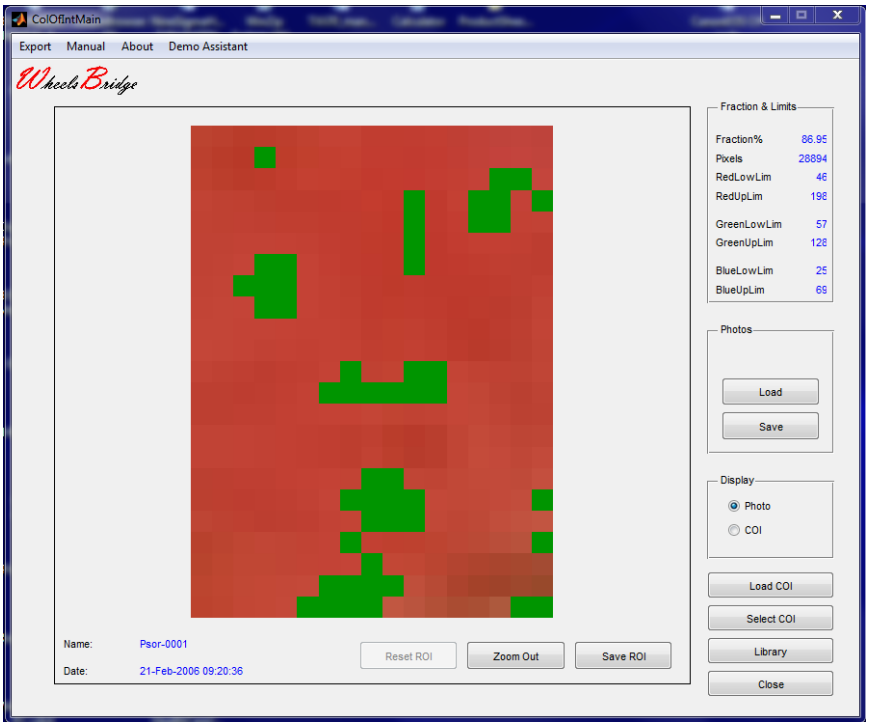


34. To eliminate dark and light areas in the selected **ROI,** grab the **Value Lower Limit** vertical indicator by the mouse pointer (the mouse pointer changes to display double arrow when the pointer is positioned over the indicator – the indicator can be dragged

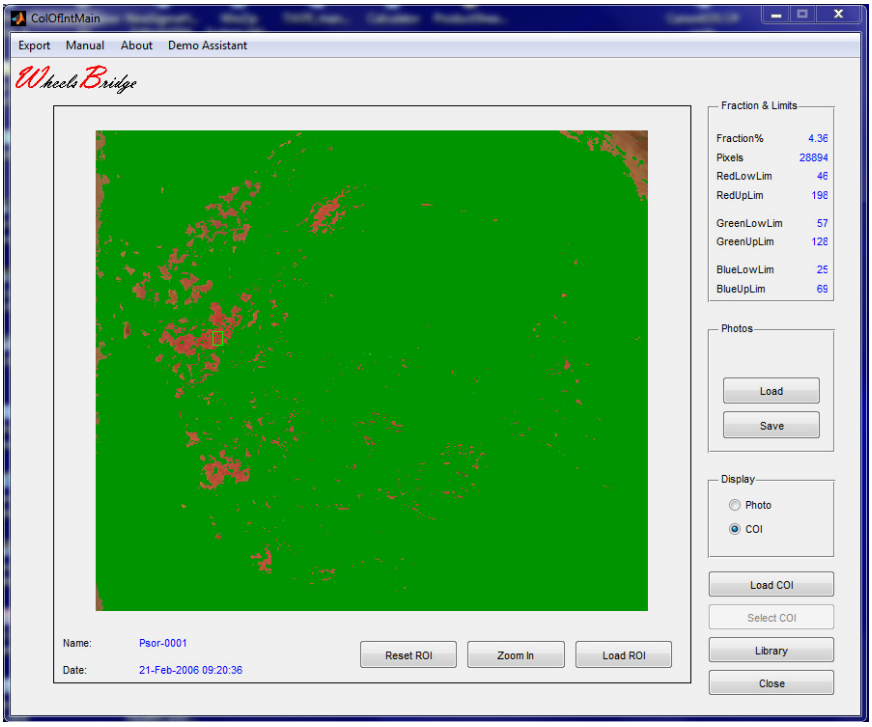
by pressing the left mouse button while moving the mouse) to the right and the **Value Upper Limit** indicator to the left.



35. Click the **Apply** button to return to the *Skin Colour Tracker* **Main** window.

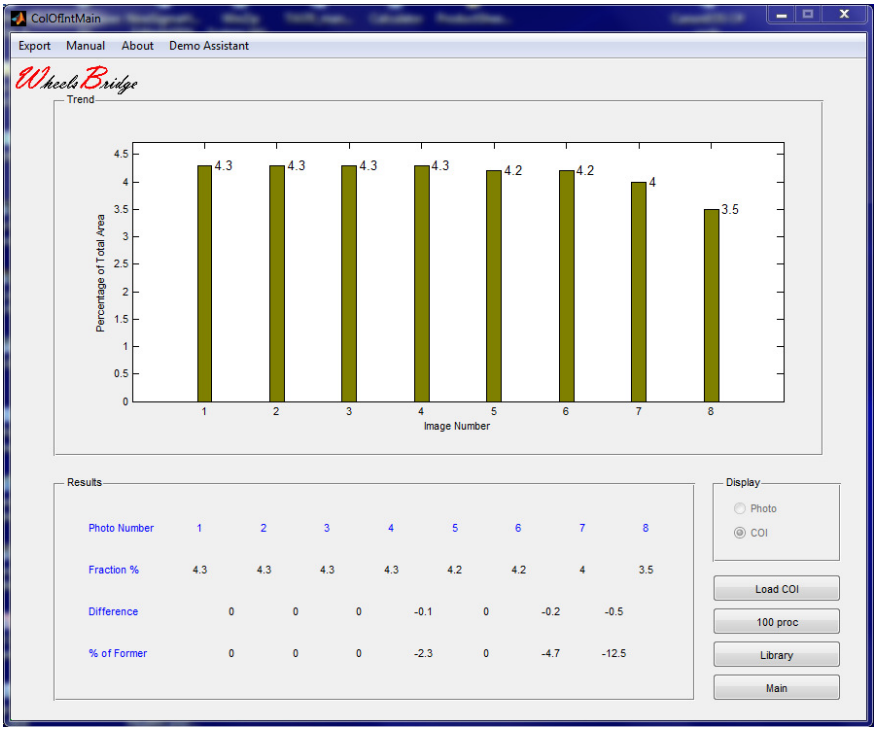


36. Click **Zoom Out** and then click the **COI** radio-button in the **Display** panel to display all areas in the photo with colours within the selected colour space.



37. Click the **Library** button to go to the *Skin Colour Tracker* **Library** page.

38. Click **Trend** to display how the extension of the areas with inflammation is reduced over time.



39. Click **Main** to return to the *Skin Colour Tracker* **Main** window and then click **Close** to close the application.

4. DETAILED DESCRIPTION

4.1 Introduction

The intended use of the *Skin Colour Tracker* is to follow changes in skin colour in a sequence of photos recorded over time, thereby making it possible to verify, quantify and document disease progress, healing processes and result of therapeutic measures or topical applications of skin care products.

The *Skin Colour Tracker* is composed of two separate windows. The main window (*Skin Colour Tracker*) is used for uploading stored photos from disk for further analysis. After selection and zooming in on a Region of Interest (**ROI),** the selected area of a photo can be exported to the **Select COI** window. In this window, the **COI**-mask is created by further limiting the set of colours represented in the **ROI**, either by use of and the **RGB** or the **HSV** colour space model. This **COI**-mask is exported back to the *Skin Colour Tracker* window where it may now be applied to any photo or a sequence of photos uploaded to the *Skin Colour Tracker***.** The **Library** page makes it possible to simultaneously work with and view a sequence of photos to which the **COI**-mask is applied. In the **Trend** page, the relative fraction

of the entire colour spaces of the individual photos that falls within the colour volume defined by the **COI**-mask can be displayed. Iterative generation of new **COI**-masks makes it possible to design the optimal **COI**-mask most accurately visualizing the skin colour change of interest.

4.2 Skin Colour Tracker window – Main page

The main page in the *Skin Colour Tracker* window after uploading a photo (Psor-0001.jpg from the TiVi70deminstration folder) is shown in the Figure below.

The *Skin Colour Tracker* **Main** page window.

1. **Load** – click this button to upload an already stored photo from disk. Select the folder in which the actual photo is stored in the **Pick a File** window by double-clicking the file name or by printing the file name in the **File Name** edit box and click **Open**.

2. **Save** – click this button to save the displayed photo.

3. When a photo is uploaded, its **Name** and capturing **Date** are displayed in the lower left corner inside the photo display frame.

4. **Load ROI** – click this button to load an Saved ROI (only in **Zoom Out** mode).

5. **Save ROI** - with the photo in **Zoom In** mode, the actual **ROI** can be saved under a separate name.

6. Draw a region of interest (**ROI**) inside the photo by

    a. Positioning the mouse pointer at the upper left corner of the **ROI** to be drawn.
    b. Press the left mouse button.
    c. Move the mouse pointer – with the left mouse button pressed – to the lower right corner of the **ROI** to be drawn.
    d. Release the mouse button.

    The boundaries of the **ROI** are now drawn in green colour. A new **ROI** can be drawn that automatically replaces the existing **ROI**. Drawing a **ROI** enables the **Zoom In** button.

7. **Zoom In** – click this button to replace the photo by the **ROI** selected. The **Select COI** button is now enabled.

8. **Select COI** – clicking this button opens the **Select COI** window to which the selected **ROI** is exported.

9. **Reset ROI** – reset the actual **ROI**.

10. **Library** - clicking this button opens the **Library** page in the *Skin Colour Tracker*.

11. **Close** – clicking this button closes the *Skin Colour Tracker*.

12. **Display Panel** – when a **COI**-mask is selected (in the **Select COI** window) this panel is enabled. Clicking the radio-button **Photo** displays the photo without **COI**-mask. Clicking the radio-button **COI** displays the photo with superimposed **COI**-mask.

13. **Fraction & Limits Panel** – when a **COI** –mask is generated the **Upper** and **Lower Limits** as well as the fraction of the displayed photo covered by the **COI**-mask are displayed in this panel.

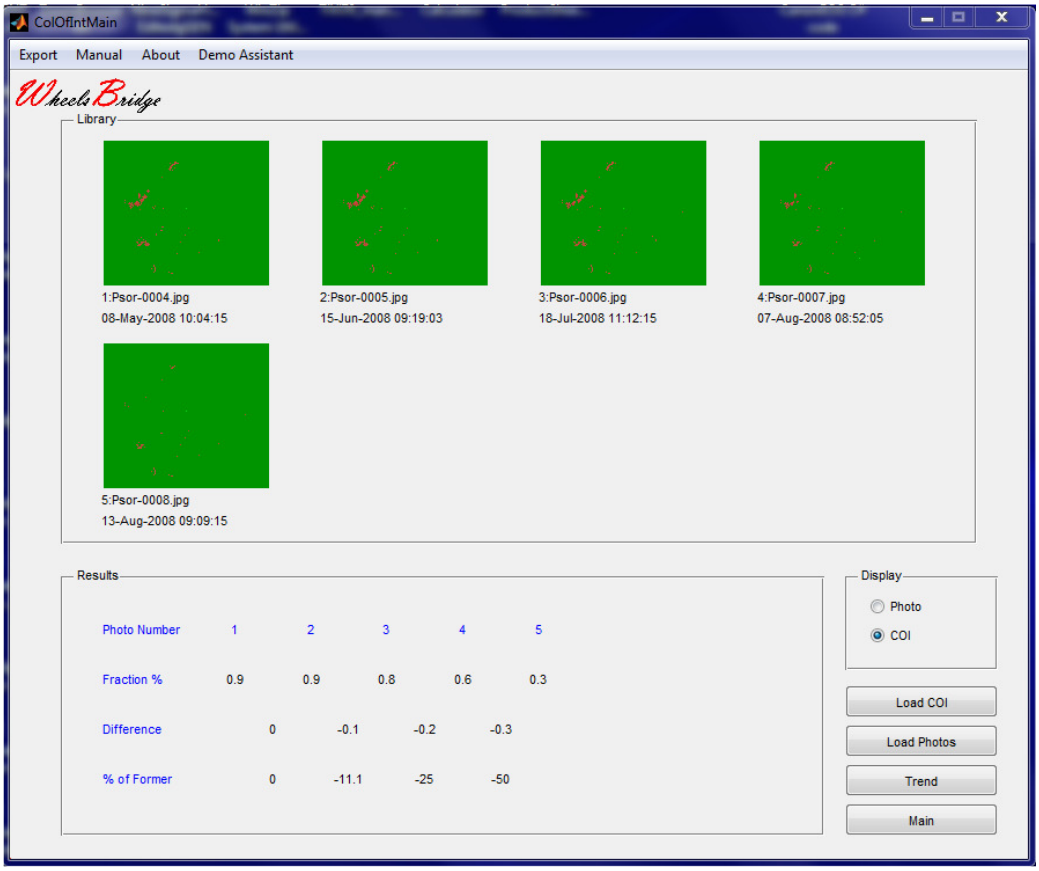
14. **Export** – exports the **Results** to an **Excel Spread**-sheet.

15. **Manual** – to display the *Skin Colour Tracker* manual on-line.

16. **About** – displays about information.

4.3 Skin Colour Tracker – Library page

In the **Library** page a maximum of eight photos in a sequence can be uploaded from disk. With the photo sequence Psor-0004.jpg – Psor-0008.jpg uploaded, the **Library** page looks like:



The **Name** and the capturing **Date** of the photos are displayed directly under the respective photo. If a **COI**-mask exists (as selected in the **Select COI** window), the **Trend** button and the **Display** panel are both enabled.

The **Results** panel displays:

- **Image Number**: the actual photo number in the sequence displayed.
- **Fraction %**: the fraction of the entire skin surface in the photo covered by the **COI**-mask.
- **Difference**: The difference in **Fraction %** between two consecutive photos.
- **% of Former**: The change in relative **COI**-mask area in % from former photo.

1. **Load Photos** – click this button to load a sequence of photos. When the button is clicked, double click the file name of the first photo in a sequence to be displayed. If more photos

exist in the same sequence (have consecutive numbers) all files (up to eight) in the sequence will be displayed.

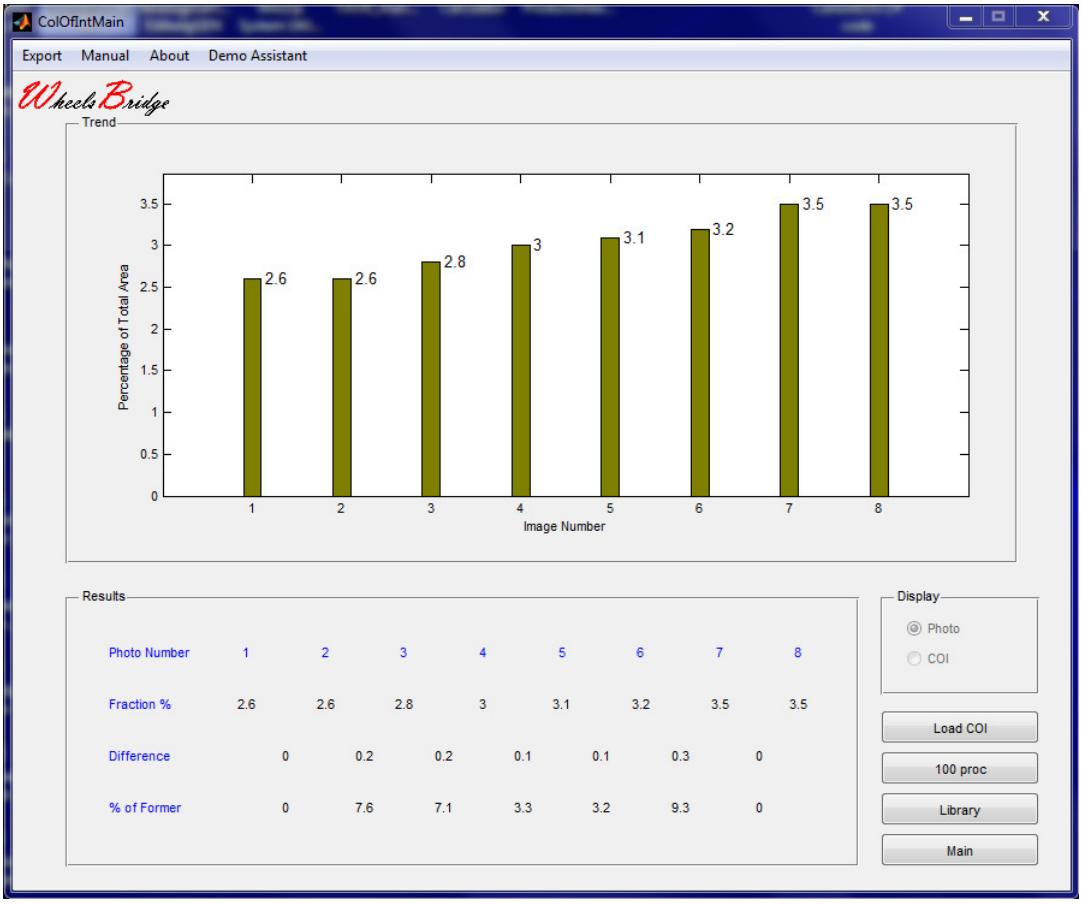
2. **Trend** – click this button to go to the **Trend** page.

3. **Main** – click this button to return to the **Main** page.

4. **Display Panel** – when a **COI**-mask is selected (in the **Select COI** window) this panel is enabled. Clicking the radio-button **Photo** displays the photos without **COI**-mask. Clicking the radio-button **COI** displays the photos with superimposed **COI**-mask.

4.4 Skin Colour Tracker – Trend page

In the **Trend** page the fraction in % of total skin area occupied by the **COI**-mask is displayed for the different photos in the sequence. This **Trend** track gives a quick overview of how the presence of a selected colour range (**COI**) changes over time.



1. **Adapt /100% Max** – click this button to adapt the maximum value of the y-scale to 100% or to the maximum **COI**-value.

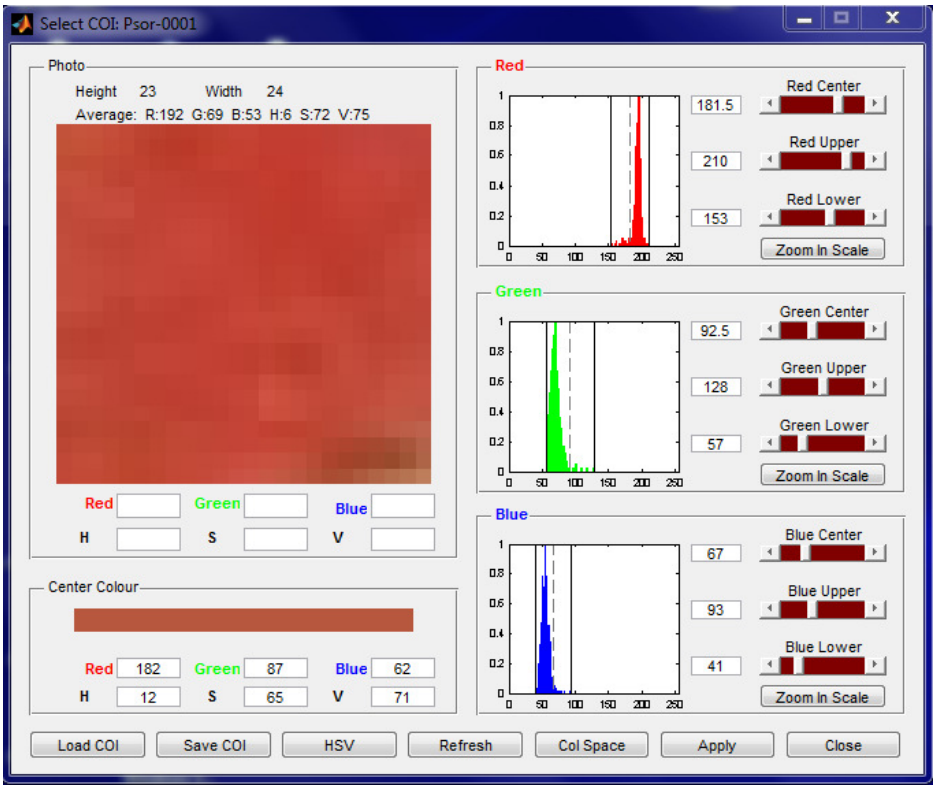
2. **Library** – click this button to return to the **Library** page.

3. **Main** – click this button to return to the **Main** page.

5. **Display Panel** – when a **COI**-mask is selected (in the **Select COI)** window) this panel is enabled. Clicking the radio-button **Photo** displays the photos without **COI**-mask. Clicking the radio-button **COI** displays the photos with superimposed **COI**-mask.

4.5 Select COI window

The **Select COI** window imports the **ROI** from the *Skin Colour Tracker* window and displays it in its photo panel. With the system in **RGB** colour model, the distributions of **Red, Green** and **Blue** colour values are displayed in the **Red, Green** and **Blue** panel respectively. In the **Center Colour** panel, the center colour (triplet of **RGB** values) of these distributions is displayed.



The **Photo** Panel.

This panel displays the **ROI** imported from the *Skin Colour Tracker* **Main** window. The **Height** and **Width** of this **ROI** are displayed above the photo. When the mouse cursor moves over the photo, the actual picture element colours (**RGB** value triplet and **HSV** value triplet) are displayed in the edit boxes below the photo.

The **Center Colour** panel.

The center color is displayed at the upper part of the panel while the **RGB** and **HSV** value triplets of the pixel at which the mouse points are displayed in the edit boxes.

The **Red, Green** and **Blue** panels.

When the system operates in **RGB** colour model mode, the **Red, Green** and **Blue** panels are displayed. The diagrams display the distribution of respective colours. The two vertical solid lines in each diagram represent the **Lower Limit** and the **Upper Limit** of the specific colour, while the dashed lines represent the center colour of the distribution (average of **Lower Limit** and **Upper Limit** values).

These lines can be moved by using one of the following three alternatives:

- Place the mouse pointer over a vertical line. The pointer symbol now changes from single arrow to double arrow. When the pointer symbol is a double arrow, press the left mouse button and drag the mouse pointer to a new position. This activity moves the line to a new position. When the left louse button is released, the line indicating **Lower** or **Upper Limit** or **Centre** has attained a new value, or

- Move the slider (**Upper**, **Lower** or **Centre**) to a new position or successively click the left or right slider arrow until the vertical line has reached the target position (avoid moving the slider by continuously pressing the arrows), or

- Print the new line target position value in the edit box and press enter.

Moving the center line (the dotted line in the axis), continuously updates the colour and its associated **RGB** and **HSV** triplets in the **Center Colour** panel.

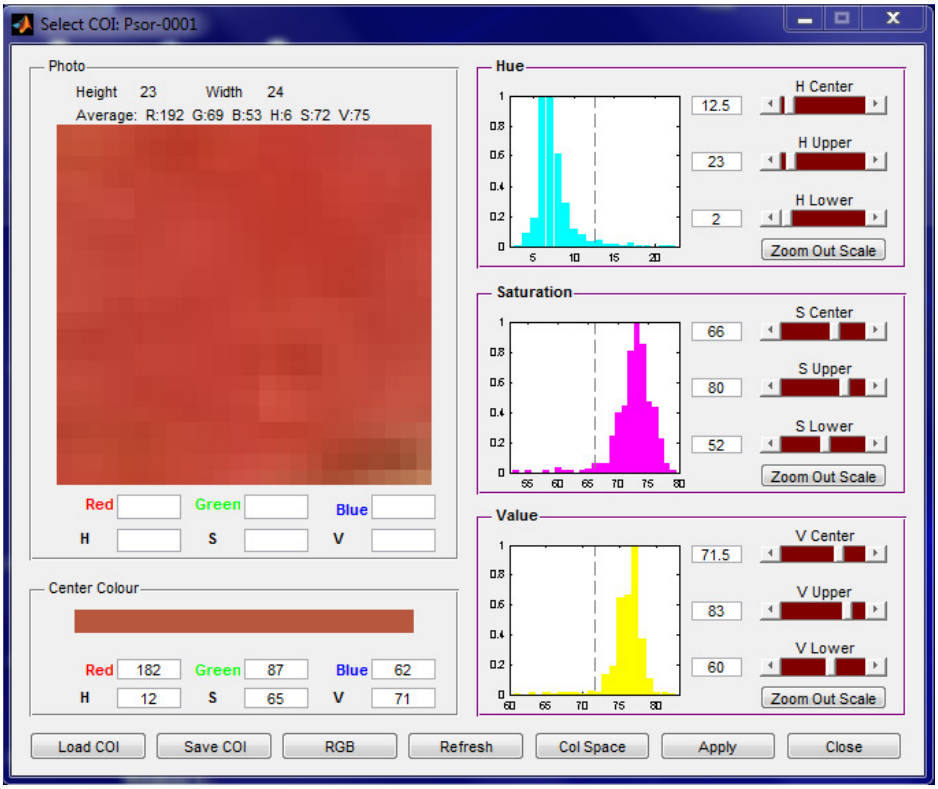
Clicking the **Zoom in Scale / Zoom out Scale** changes the limits of the x-axis to **Lower Limit** and **Upper Limit** respectively 0 and 255.

The buttons at the lower part of the **Select COI** window have the following functions:

1. **Load COI** – loads stored **COI** coordinates from file. In the **Pick a File** window, select the actual folder and double-click the **COI** to be loaded.

2. **Save COI** – saves the actual **COI** coordinates from file. In the **Save As** window, select the folder into which the **COI** file is to be saved and print the name of the file in the **File name** edit box. Click the **Save** button.

3. **HSV/RGB** – click this button to set the system to operate alternatively in the **RGB** or **HSV** colour model mode. When the system is set to **HSV** mode, the **Select COI** window should look like (in this example all x-scales in the **Hue, Saturation** and **Value** panels are set to scale **Zoom in Scale**):



When the system operates in **HSV** colour model mode, the **Hue, Saturation** and **Value** panels are displayed. The diagrams display the distribution of respective parameters. The two vertical solid lines in the axes represent the **Lower Limit** and the **Upper Limit** of the specific parameter, while the dashed line represents the center of the distribution (average of **Lower Limit** and **Upper Limit** values). When the x-scales are set to **Zoom in Scale**, the vertical solid lines representing **Lower Limit** and **Upper Limit** coincides with the left and right border axis respectively.

These vertical lines can be moved by using one of the following three alternatives:

- Place the mouse pointer over a vertical line. The pointer symbol now changes from single arrow to double arrow. When the pointer symbol is a double arrow, press the left mouse button and drag the mouse pointer to a new position. This activity moves the line to a new position. When the left mouse button is released, the line indicating **Lower** or **Upper Limit** or **Centre** has attained a new value, or

- Move the slider (**Upper**, **Lower** or **Centre**) to a new position or successively click the left or right slider arrow until the vertical line has reached the target position, or

- Print the line target position value in the edit box and press enter.

Moving the center line (the dotted line in the axis), continuously updates the colour and its associated **RGB** and **HSV** triplets in the **Center Colour** panel.

Clicking the **Zoom in Scale / Zoom out Scale** changes the limits of the x-axis to **Lower Limit** and **Upper Limit** respectively 0 and 360 (for **Hue**) and 0 and 100 (for **Saturation** and **Value**).

4. **Refresh –** clicking this button, displays the original **ROI** imported and resets the **Upper** and **Lower Limit** in each diagram.

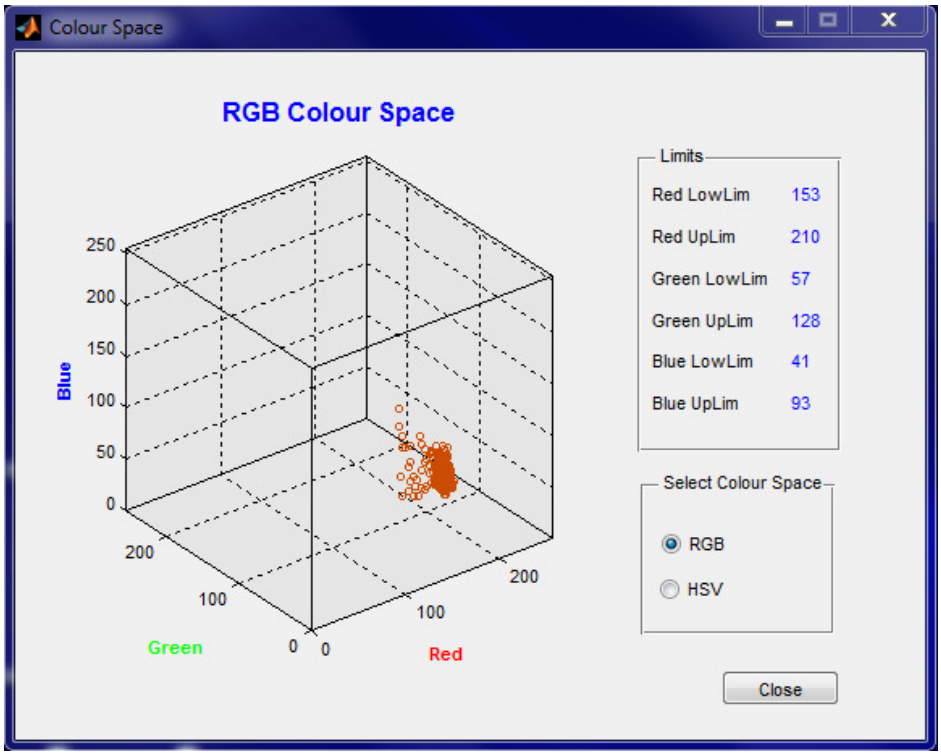
5. **Col Space –** clicking this button opens the **Colour Space** window.

6. **Apply** – clicking this button exports the **COI**-mask generated (by exporting the **Lower Limit** and the **Upper Limit** selected) back to the *Skin Colour Tracker* where it is applied to the original photo and other photos that are uploaded from the disk. The **Select COI** window is closed.

7. **Close** – clicking this button closes the **Select COI** window without exporting the **COI**-mask.

4.6 Colour Space window

1. Click the **Col Space** button to open the **Colour Space** window.



2. **Changing the view** – position the **Mouse Pointer** inside the diagram and press the left **Mouse** button. When the **Mouse** is moved the view angle changes.

3. **Limits panel** – displays the actual **Upper** and **Lower Limit** settings.

4. **Select Colour Space** – clicking the **RGB** radio-button selects the **RGB Colours Space** while clicking the **HSV** radio-button selects the **HSV Colour Space**.

5. **Close** – close the **Colour Space** window.

5. ADDITIONAL APPLICATIONS

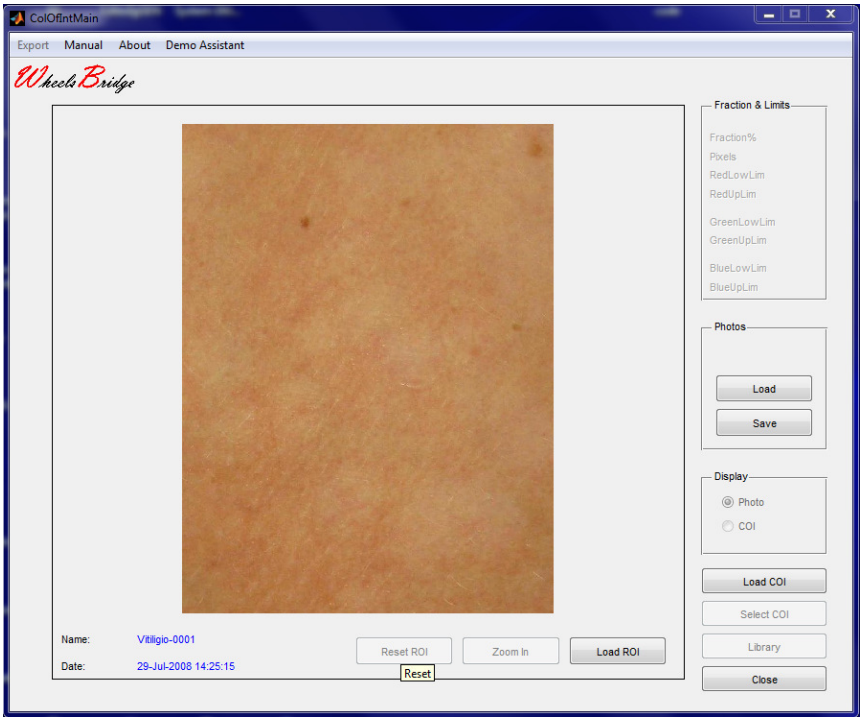
In addition to the application discussed in the **Getting Started** section, the *Skin Colour Tracker* is well suited for assessment of other skin colour changes such as these associated with *Vitiligio* and facial brown spots. Comparison of the progression of the colour changes of isolated skin spots assumes that the photos are captured under the same conditions, under uniform illumination and from the same distance.

5.1 Mild Vitiligio

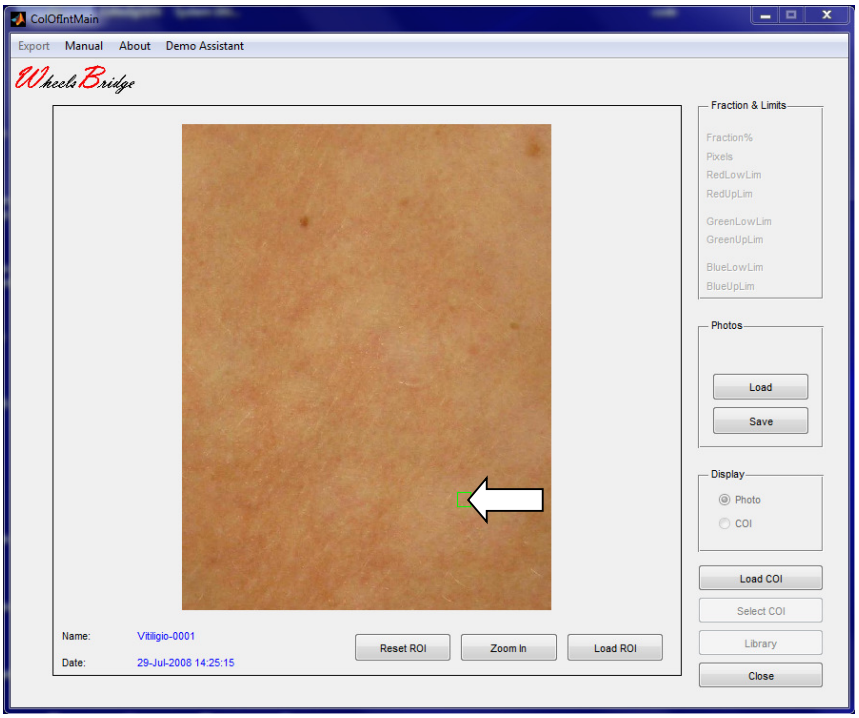
The aim of this application is to determine the fraction of a skin surface that is plagued with a mild form of *Vitiligio* – a skin disease in which the degree of pigmentation is locally diminished. In this particular case, the task is to determine which of the following two skin sites demonstrates the higher degree of *Vitiligio*:

From visual inspection alone, it is difficult to tell if the left or the right photo demonstrates the higher degree of *Vitiligio*.

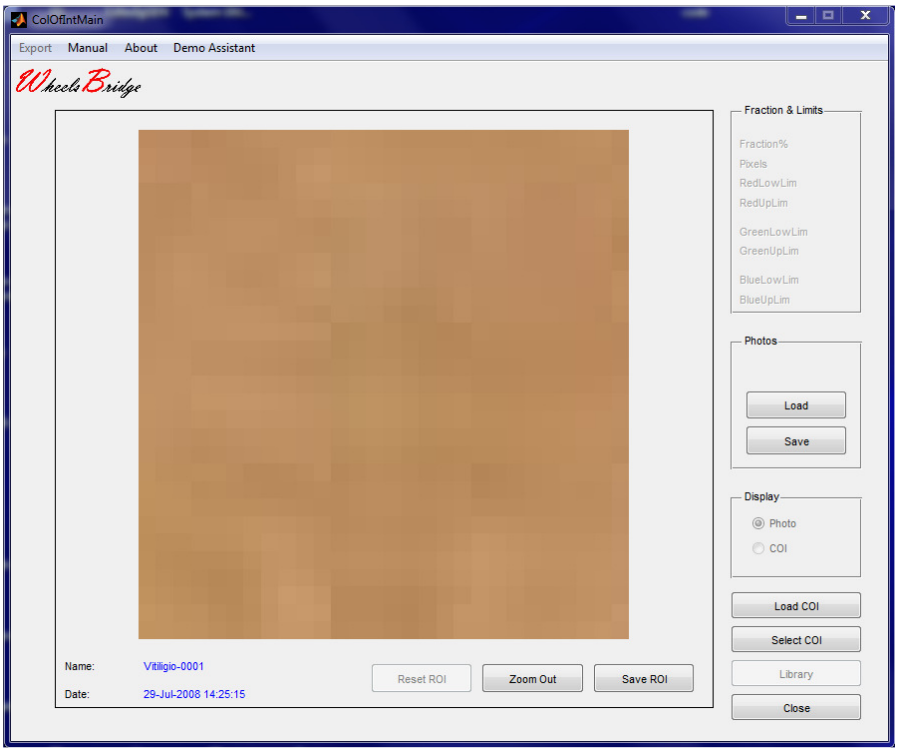
1. Start the *Skin Colouer Tracker* and **Load** the photo Vitiligio-0001 from the **TiVi70demonstration** folder.



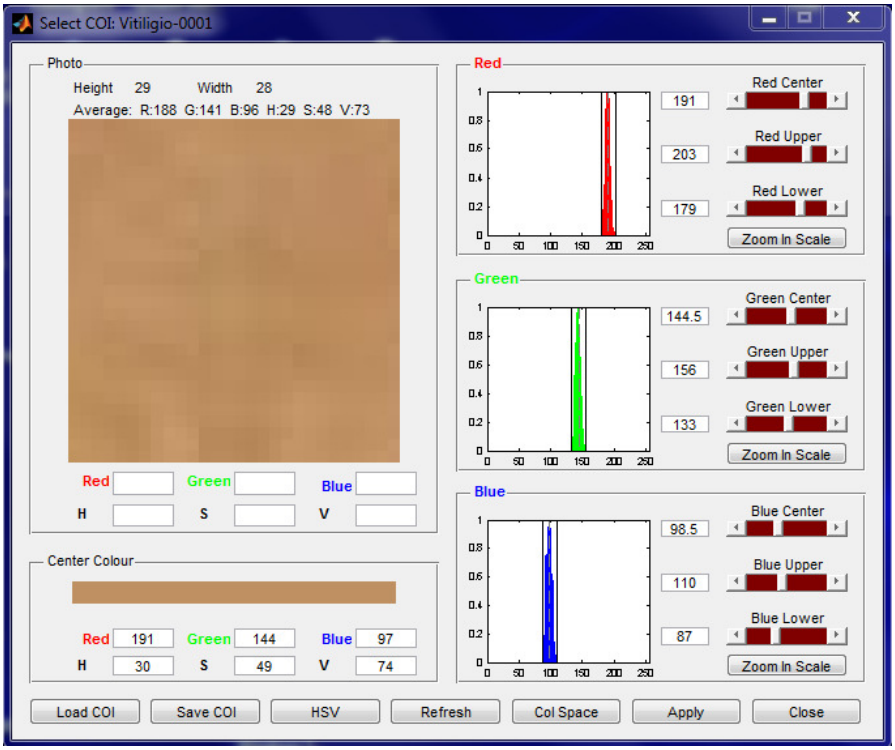
2. Draw a **ROI** over an area that colour-wise can be characterized as *Vitiligio*.



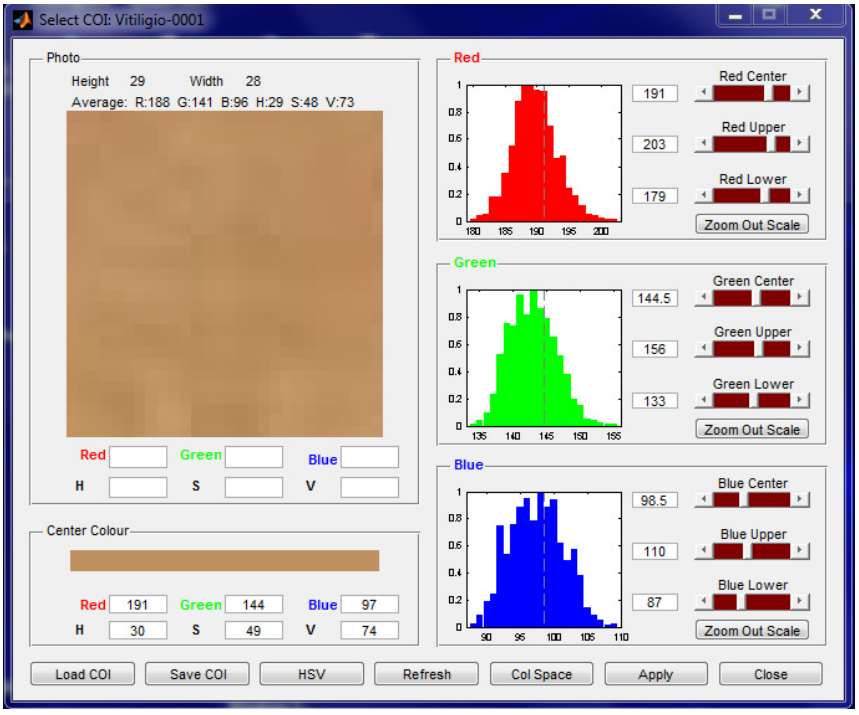
3. Click **Zoom In.**



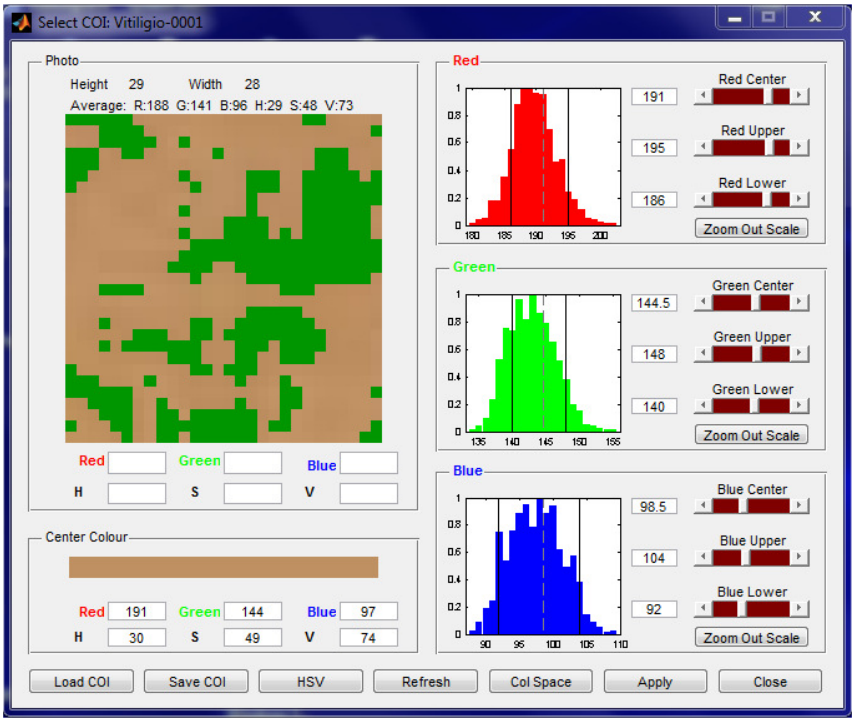
4. Click **Select COI** to open the **Select COI** window.



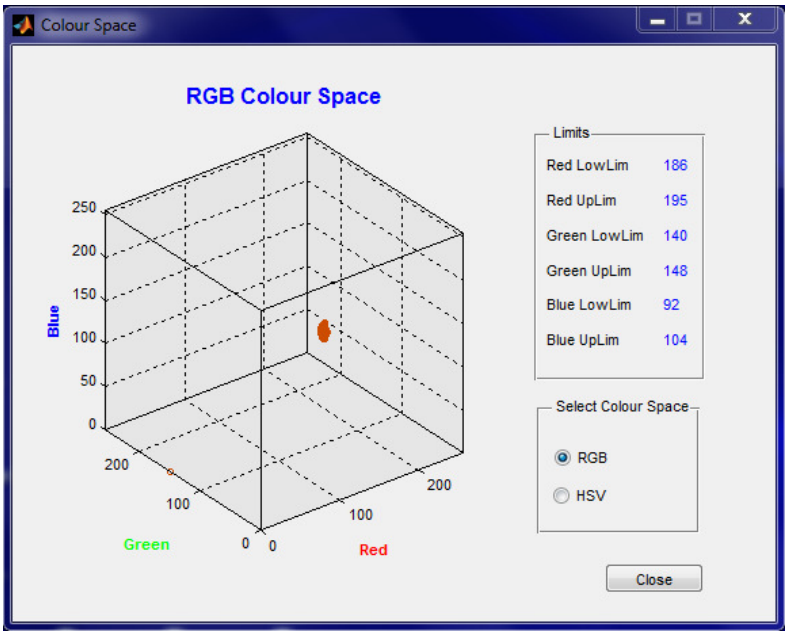
5. Click **Zoom in Scale** in the **Red, Green** and **Blue** panel to expand the colour scales.



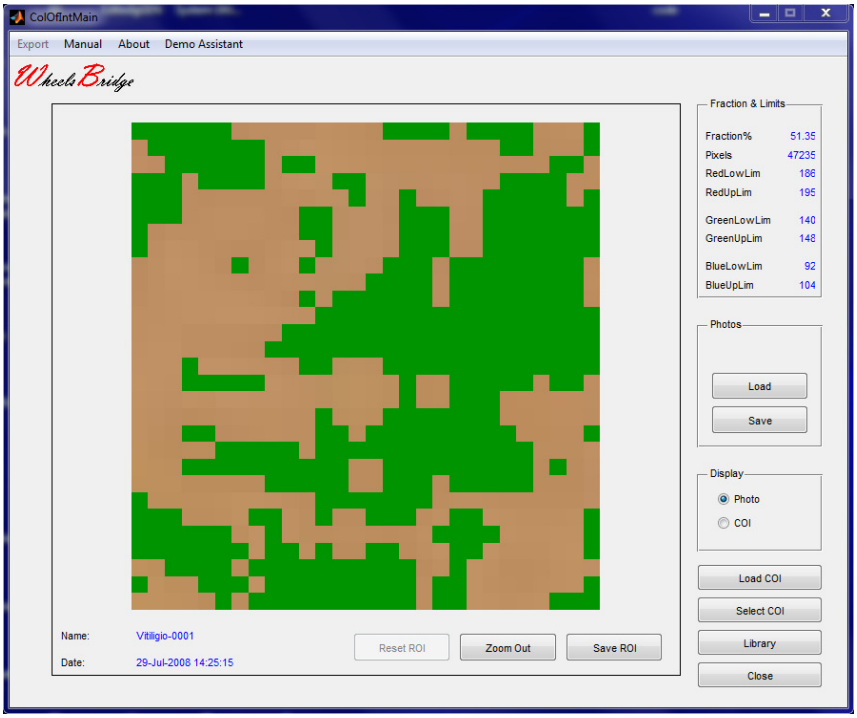
6. To reduce the size of the **COI** and make the **COI** volume smaller and more compact, move the vertical **Upper** and **Lower Limit** lines closer to the centre colours, by use of the sliders.



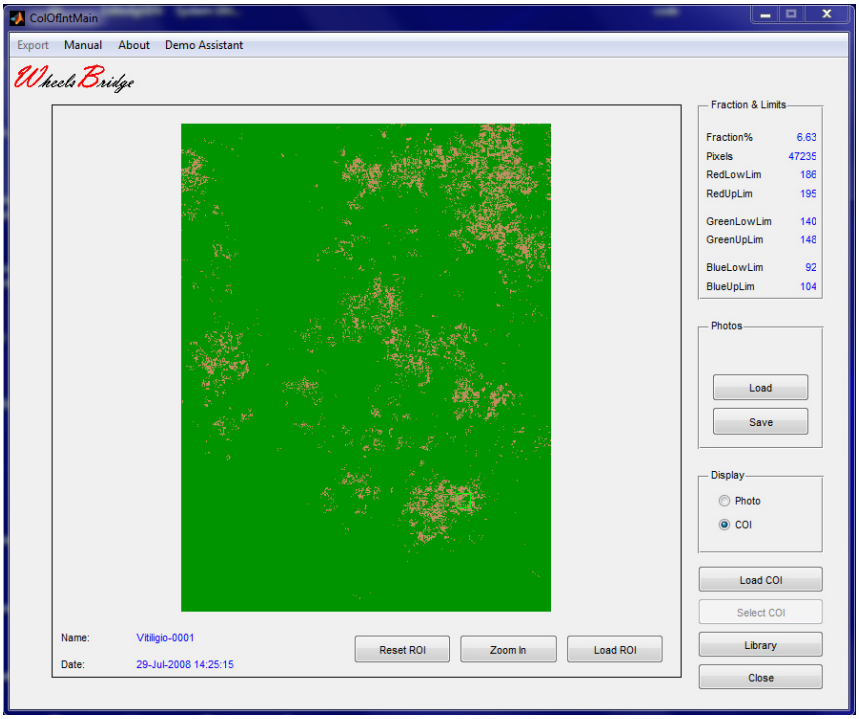
7. To view the **COI** volume in the **Colour Space,** click the **Col Space** button.



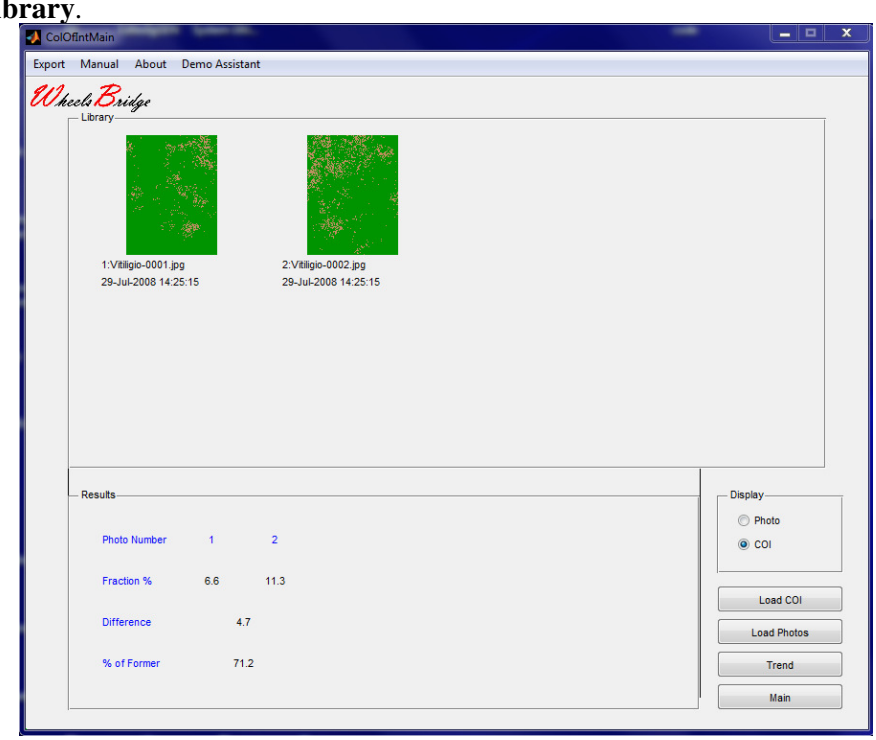
8. With the **Mouse Pointer** inside the diagram, press the left **Mouse** button and move the **Mouse** to view the **RGB Colour Space** from different angles. Close the **Colour** Space window to return to the **Select COI** window. In the **Select COI** window, click the **Apply** button to export the **COI Mask** to the *Skin Colour Tracker* window.



9. Click the **Zoom Out** button and then the **COI** radio-button to display the sites with *Vitiligio* in the Vitiligio-0001 photo.



10. Click the **Library** button, click the **Load** button and select the Vitiligio-0001 file. Click the **COI** radio-button to display both photo Vitiligio-0001 and Vitiligio-0002 in the **Library**.

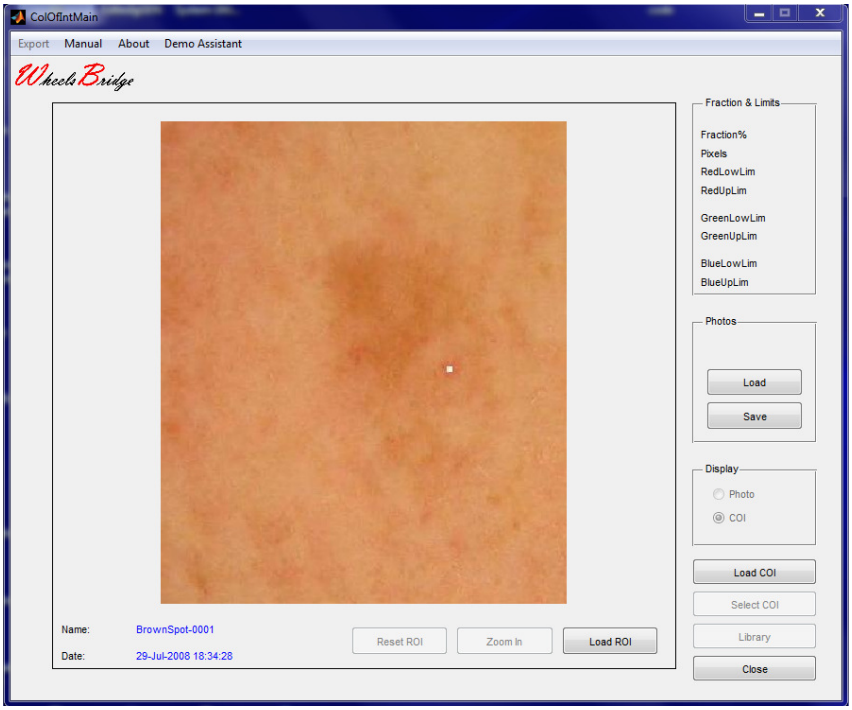


11. From the **Results** panel we can conclude that the photos Vitiligio-0001 and Vitiligio-0002 demonstrate a *Vitiligio* fraction of 6.6 and 11.3% respectively, based on the **COI** mask used.

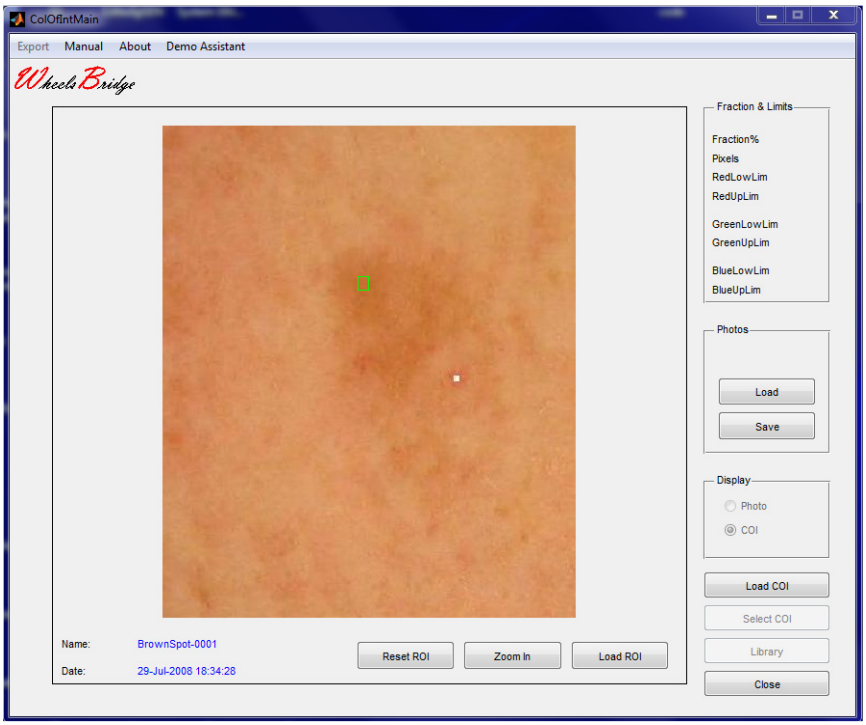
5.2 Facial brown spot

In this application an age-related brown facial spot is analyzed and the change in two photos captured at different points in time is demonstrated.

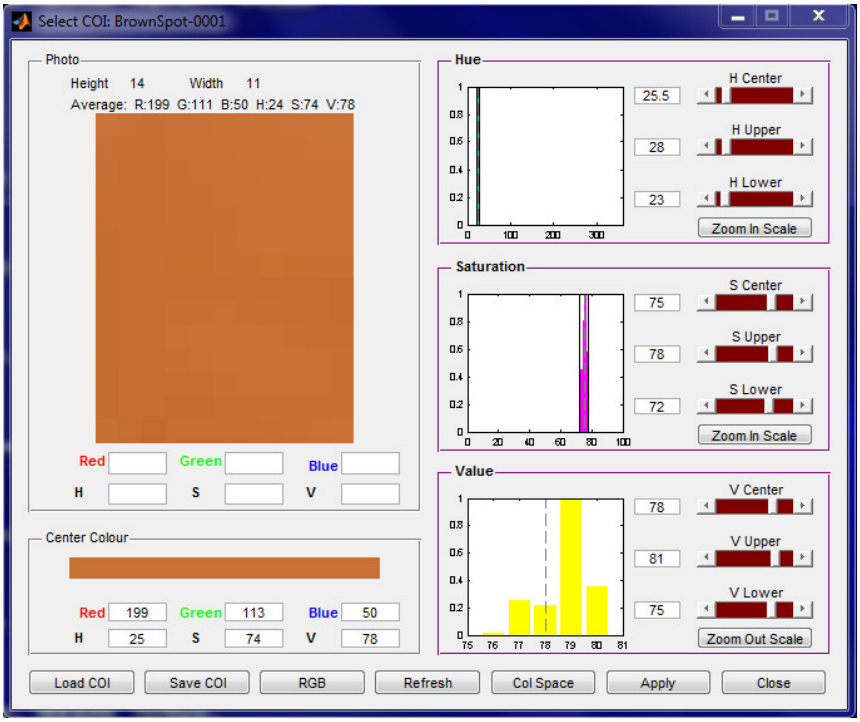
1. Open the *Skin Colour Tracker* and load the file BrownSpot-0001.



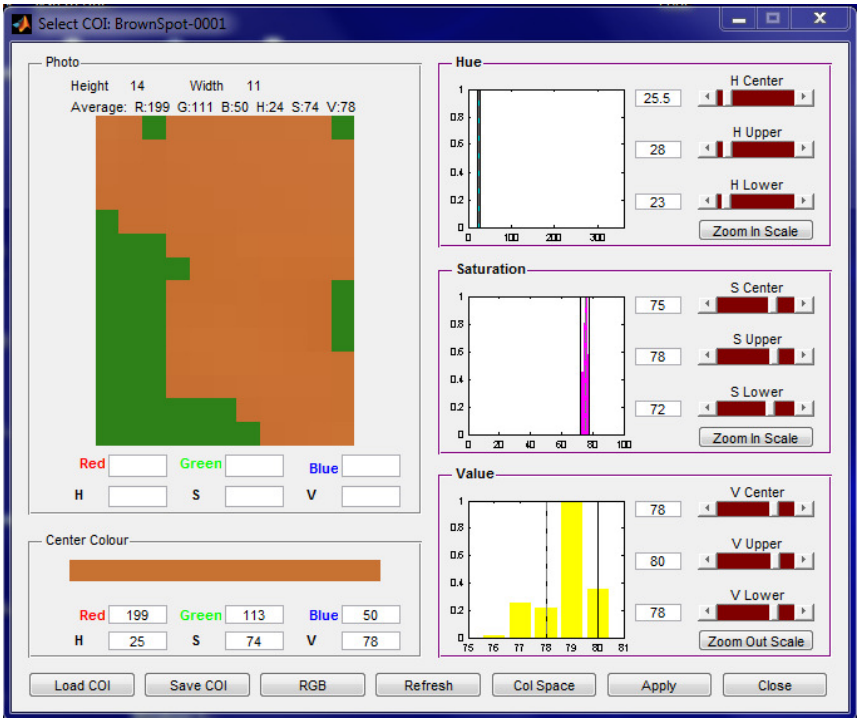
2. Draw a **ROI** over a brown spot.



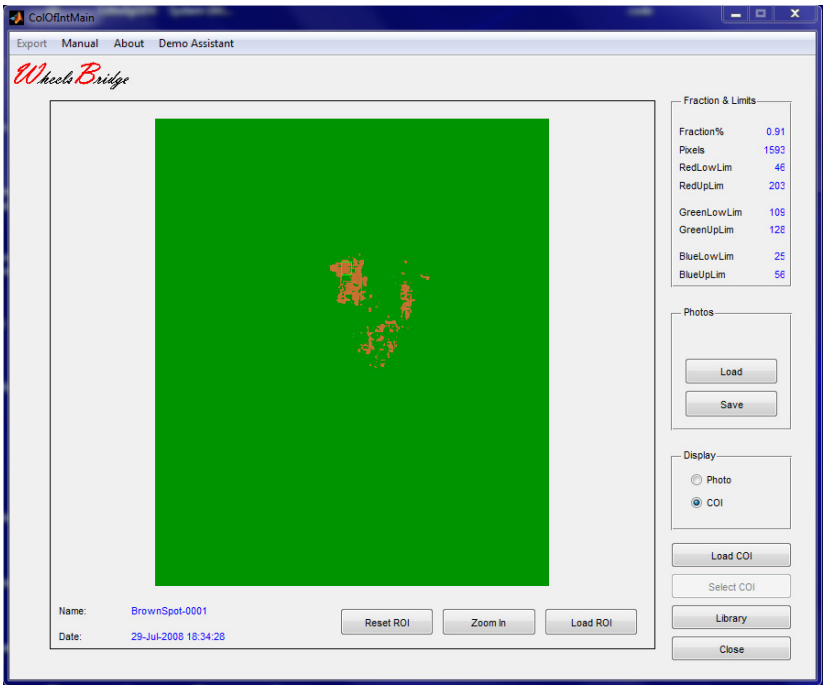
3. Click **Zoom In** and the **Select COI** to open the **Select COI** window. In the **Select COI** window, click the **HSV** button. Click the V **Zoom in Scale** button.



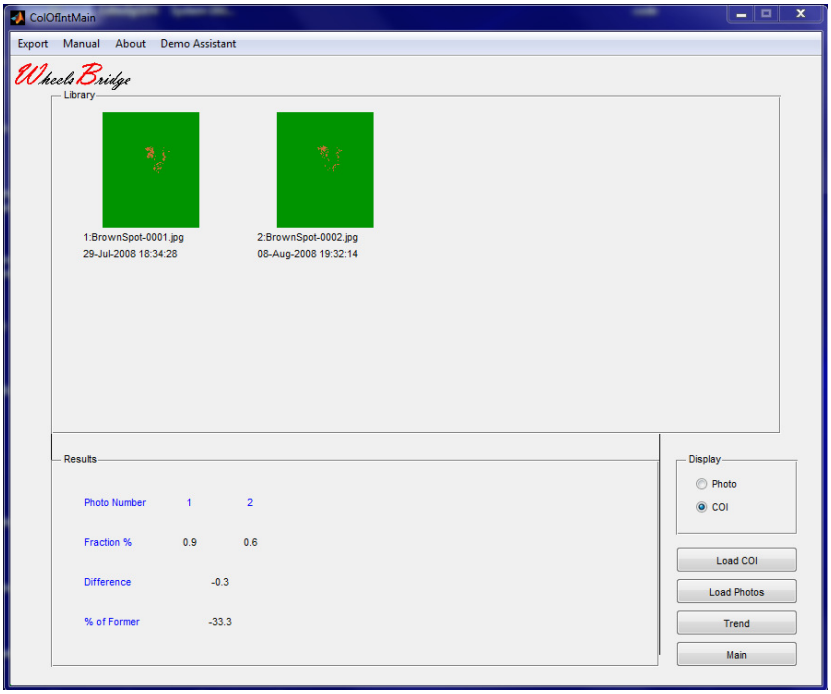
4. To eliminate light and dark areas from the **COI** mask, move the **V Upper** and **V Lower** sliders towards the centre.



5. Click the **Apply** button to export the **COI** mask to the *Skin Colour Tracker* window. Click **Zoom Out** in the *Skin Colour Tracker* window. Click the **COI** radio-button.



6. Click **Library,** click the **Load** button and load the BrownSpot-0001 photo from the **TiVi70demonstration** folder. Click the **COI** radio-button.



7. We conclude that the size of the brown spot has been reduced by about 33 %.