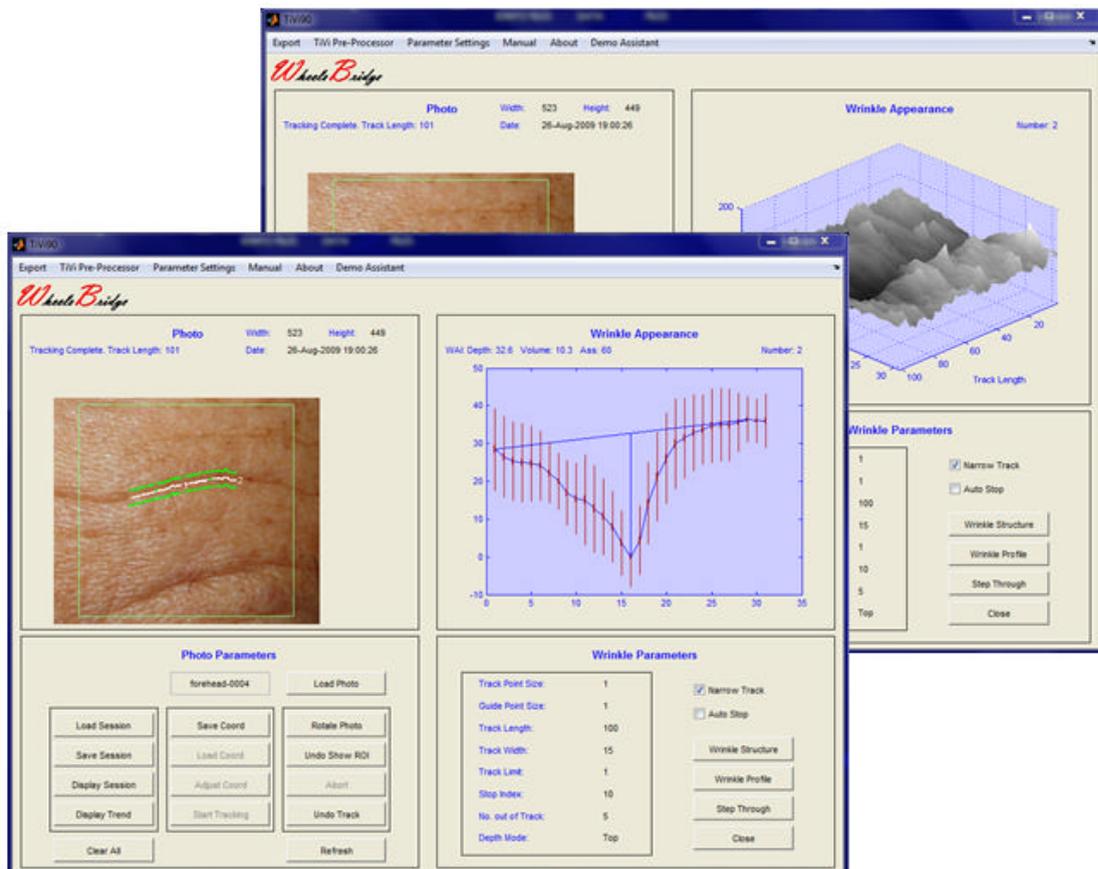




Wheels Bridge



Wrinkle Analyzer TiVi90 User Manual

User Manual 3.3
Version 3.3
October 2013

PIONEERS IN TISSUE VIABILITY IMAGING

TiVi90 Wrinkle Analyzer

Dear Valued Customer!

Welcome to the WheelsBridge Wrinkle Analyzer TiVi90 system intended for automatic analysis of wrinkle appearance. The Wrinkle Analyzer TiVi90 was designed especially for observer-independent analysis of wrinkles in association with evaluation of skin care products and follow up of treatment regimes.

The Wrinkle Analyzer TiVi90 utilizes a highly sensitive digital camera equipped with polarization filters making it possible to suppress (cross-polarization mode) or enhance (co-polarization mode) 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 Wrinkle Analyzer TiVi90 software the following are of particular interest:

- ? Automatic capturing of photos.*
- ? Automatic tracking of wrinkles.*
- ? Display of wrinkle profile.*
- ? 3D display of wrinkle structure.*
- ? Quantitative measures of wrinkle depth, volume and asymmetry appearance.*
- ? Simultaneous analysis of up to 10 wrinkles.*
- ? Trend analysis window to display changes in wrinkle appearance over time.*
- ? Creation of wrinkle maps.*
- ? Possibility to load and save entire sessions.*
- ? Possibility to load and save wrinkle coordinates.*
- ? Operates in cross- and co-polarization mode.*
- ? All data can be exported to ASCII-format spread sheets.*

We are convinced that the Wrinkle Analyzer TiVi90 will be a productive tool in the assessment and follow-up of wrinkle appearance following treatment with skin care products.

Thank you for choosing the WheelsBridge Wrinkle Analyzer TiVi90.

WheelsBridge AB

TiVi90 Wrinkle Analyzer

Information in this document is subject to change without notice and does not represent a commitment on the part of WheelsBridge AB. No part of this manual may be reproduced or transmitted in any form or by any means, electronically or mechanically, including photocopying and recording, for any purpose without the written permission of WheelsBridge AB.

Any use of application of WheelsBridge products must be performed by properly trained and qualified personnel. WheelsBridge AB takes no responsibility for action taken on the basis of information derived from the use of the product described in this manual or from consequential damages in connection with furnishing, performance or use of this manual.

Licensee's limited rights are governed by the license agreement between WheelsBridge AB and MathWorks. Licensee may not modify or remove any license agreement file (MathWorks or third party) that is included with the MCR Libraries ("MCR Library License"). Licensee of this Application accepts the terms of the MCR Library License.

WheelsBridge is a registered trade mark.

1. INTRODUCTION

Wrinkles frequently appear on the parts of the body where there has been extensive sun exposure. Wrinkles can appear as fine structures or deep furrows. Smoking, skin type, heredity occupational and recreational habits are factors that all promote wrinkling of the skin. Many products have been developed for the reduction of wrinkles or rather their appearance, but few cost-effective techniques are to date available for quantitative analysis of wrinkle appearance. The *Wrinkle Analyzer TiVi90* is a software package that analysis several features of wrinkles based on photos captured by polarization spectroscopy camera technology.

The intended use of the *Wrinkle Analyzer TiVi90* is to analyse the appearance of wrinkles in experimental in laboratory applications. It is not yet approved for the diagnosis and treatment of disease.

2. OPERATING PRINCIPLE

The *Wrinkle Analyzer TiVi90* operates in the following way:

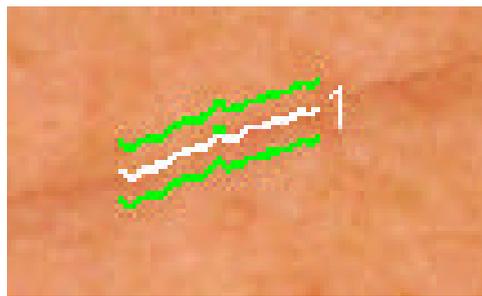
1. The TiVi camera is set to cross- or co-polarization mode by adjusting Illuminator filters.
2. A photo of the actual skin area is captured.
3. The photo is uploaded to the *Wrinkle Analyzer TiVi90* main window.
4. A region of interest (ROI) is drawn and displayed.
5. Automatic tracking of a wrinkle starts by pointing at the wrinkle using the mouse.
6. The wrinkle profile is automatically calculated and features of the wrinkle appearance (depth, volume and asymmetry) are displayed.
7. The cross section of a wrinkle (structure) can be visualized in 3D.
8. Up to 10 wrinkles in the same photo – referred to as a session - can be analyzed simultaneously.
9. A complete session can be saved and uploaded again at a later occasion for further analysis.
10. An infinite number of sessions can be displayed in separate windows simultaneously.

TiVi90 Wrinkle Analyzer

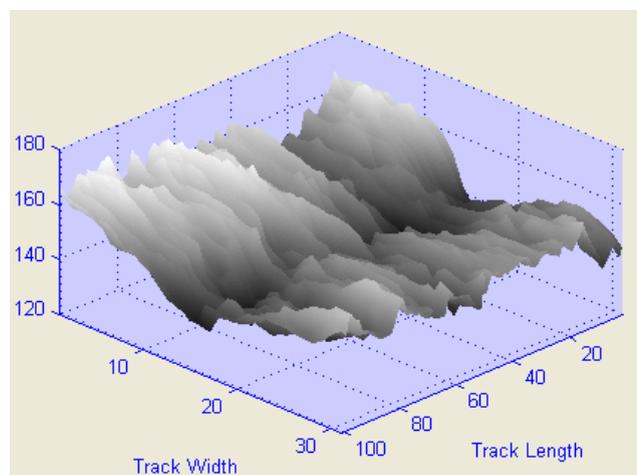
11. The centre coordinates of a set of wrinkles can be saved and re-loaded to be applied in other photos.
12. The results of up to six sessions can be exported to an integrated **Trend Analyzer** for analysis of changes in wrinkle appearance over time.
13. The overall result from the **Trend Analyzer** can be stored in a MS Excel spread-sheet for further analysis.
14. All basic recorded and calculated data can be stored in a MS Excel spread-sheet.

3. WRINKLE PARAMETERS

The *TiVi90 Wrinkle Analyzer* automatically tracks a wrinkle (white trace) pointed at by the mouse within set boundaries (green traces) based on the local intensity within these boundaries of a photo captured by way of a polarization spectroscopy camera.

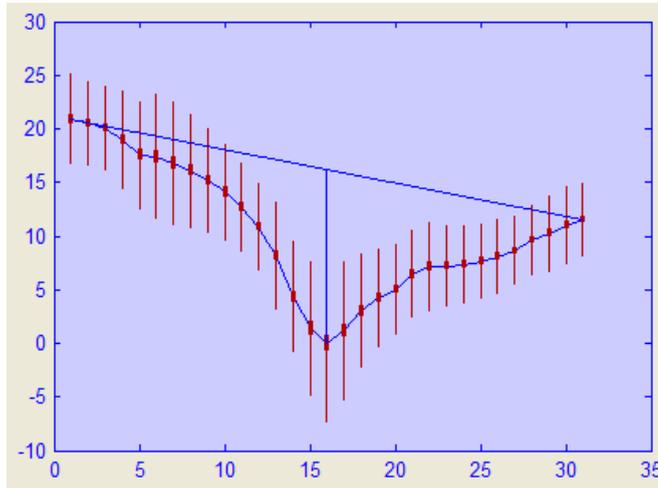


When a tracking procedure is complete, the track is assigned a number and a green indicator is placed at the centre of the track. Each vertical line in the intensity projection of the photo between the two green boundaries constitutes a local profile of the wrinkle. The tracking procedure is based on successively finding the minimum value of the intensity profile over the entire length of the track. Based on these separate intensity profiles, a wrinkle structure is composed displaying the intensity changes throughout the entire length of the track.



TiVi90 Wrinkle Analyzer

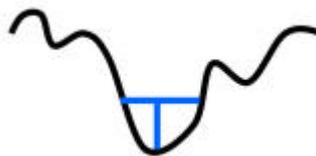
By calculating the average profile along the track, a **Wrinkle Profile** is constructed.



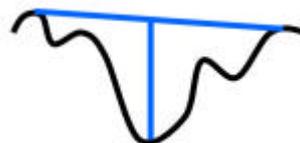
From this **Wrinkle Profile** several key features characterizing the wrinkle can be calculated.

The **Wrinkle Depth** is calculated as the length of the vertical line connecting the minimum value to the cross-point of the line that connects the endpoints of the wrinkle. The endpoints of the wrinkle can be defined in four different ways:

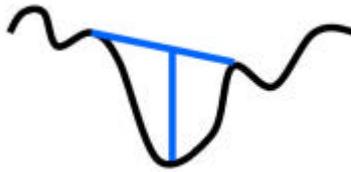
1. **Fix setting** – the endpoints of the **Wrinkle Profile** are defined as starting from the 10th pixel at each side of the minimum value.



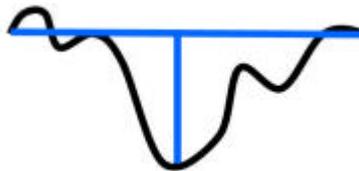
2. **Top setting** – the endpoints of the **Wrinkle Profile** are defined as starting from the maximum value at each side of the minimum value (Default).



3. **First Max setting** – the endpoints of the **Wrinkle Profile** are defined as starting from the first maximum value at each side of the minimum value.



4. **Endpoints setting** – the endpoints of the **Wrinkle Profile** are defined as starting from the upper and lower boundaries respectively.



The **Wrinkle Volume** is calculated as the area between the line that connects the endpoints of the wrinkle and the wrinkle profile.

The **Wrinkle Asymmetry** is calculated as the relation between the area to the left and the right of the horizontal line according to the formula:

$$200 * (\text{Left Area} - \text{Right Area}) / (\text{Left Area} + \text{Right Area})$$

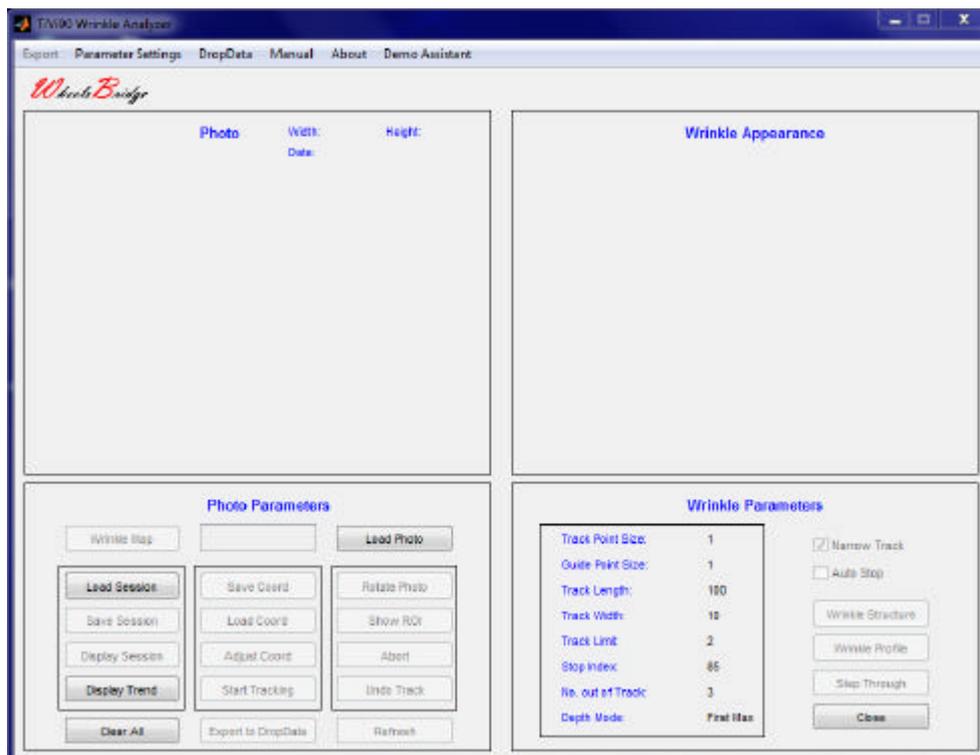
In the **GETTING STARTED** section these and other features are further explained by way of an example

3. GETTING STARTED

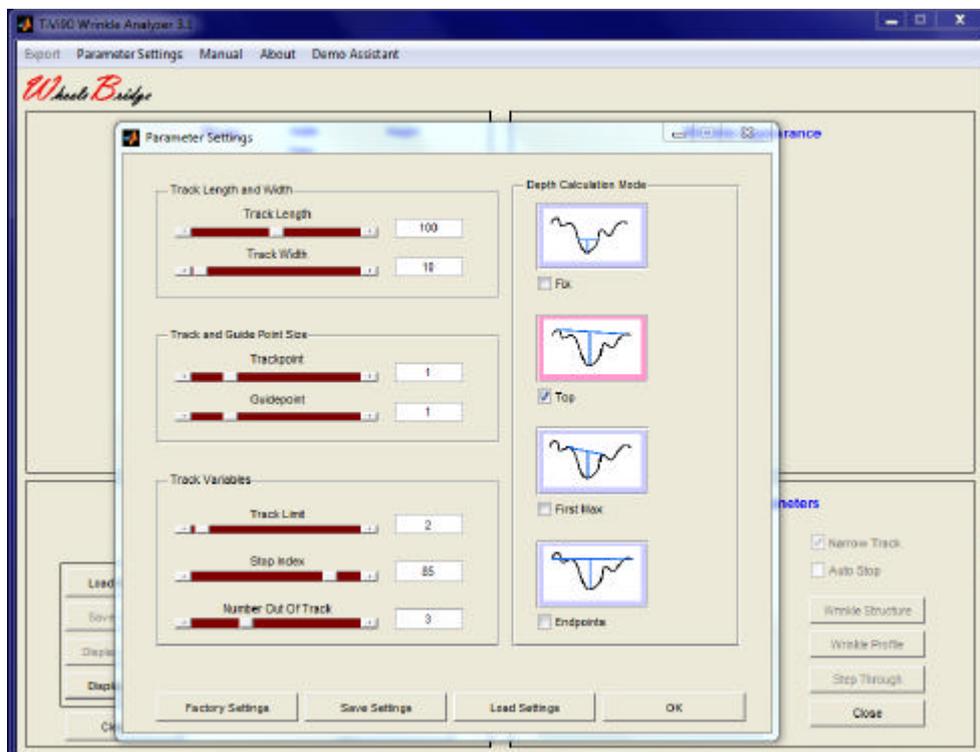
The basic features of the *Wrinkle Analyzer TiVi90* are probably best explained by way of an example. In the following example it is assumed that the photos *forehead-0001.jpg* – *forehead-0006.jpg* have been captured by a Canon EOS550D / 650D TiVi camera with polarizing filters and stored in the *TiVi90demonstration* folder. These photos demonstrate wrinkles appearing in the forehead of a male subject with increasingly frowning forehead. The task is to analyze the wrinkle appearance parameters (depth, volume and asymmetry) and to display the wrinkle profiles and structures respectively.

1. Open the *Wrinkle Analyzer TiVi90* main window.

TiVi90 Wrinkle Analyzer

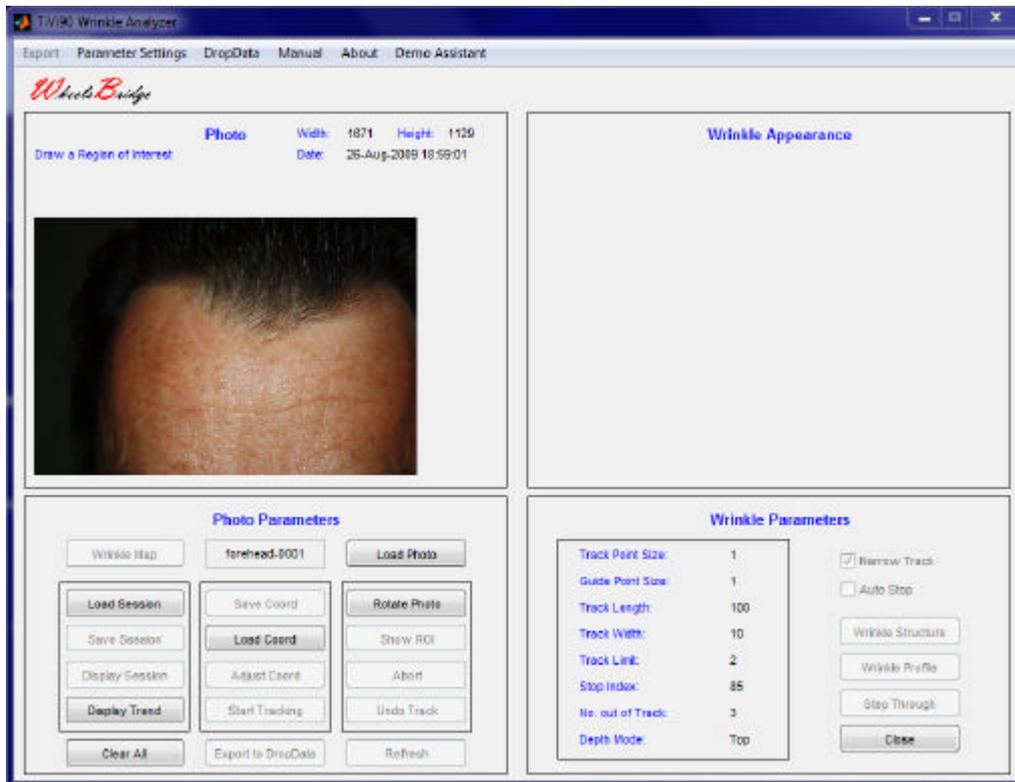


2. Click the **Parameter Settings** pull-down menu to open the **Parameter Settings** window. Set the parameters according to the figure below by dragging the sliders or inserting the numbers directly into the edit boxes and check the **Top** check-box in the **Depth Calculation Mode** panel. The window should now look like:



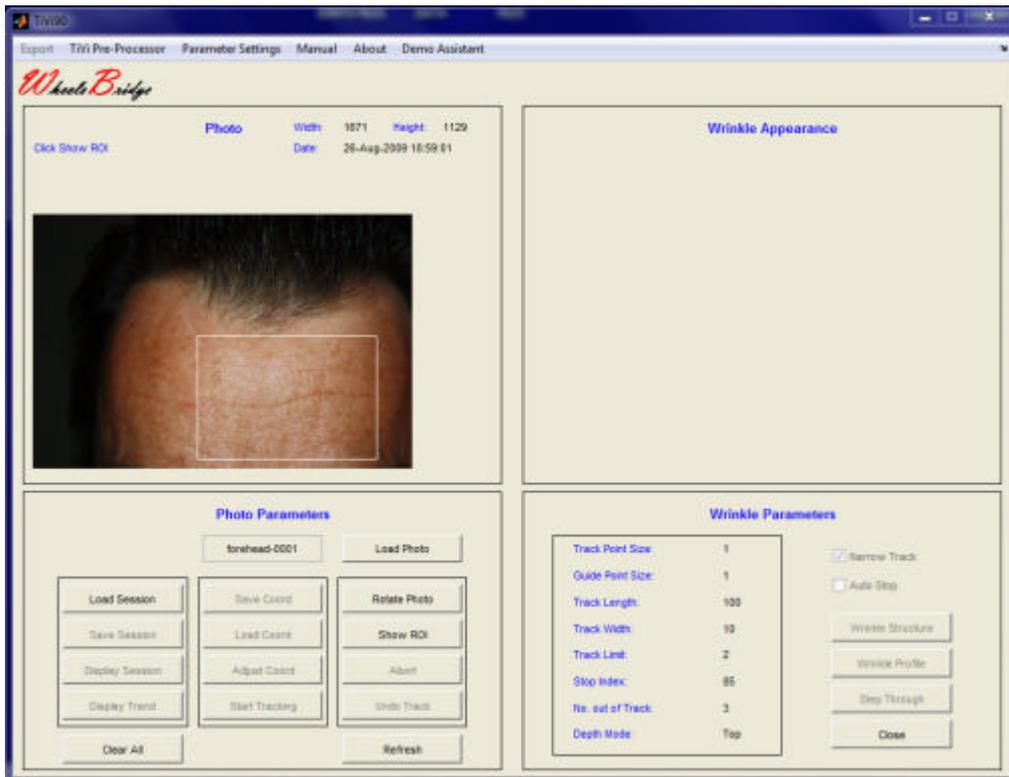
TiVi90 Wrinkle Analyzer

3. Click the **OK** button to store the parameters and close the **Parameter Settings** window.
4. Click the **Load Photo** button and navigate to the *TiVi90demonstration* folder. Double-click the file *forehead-0001* file. The TiVi90 main window should now look like:

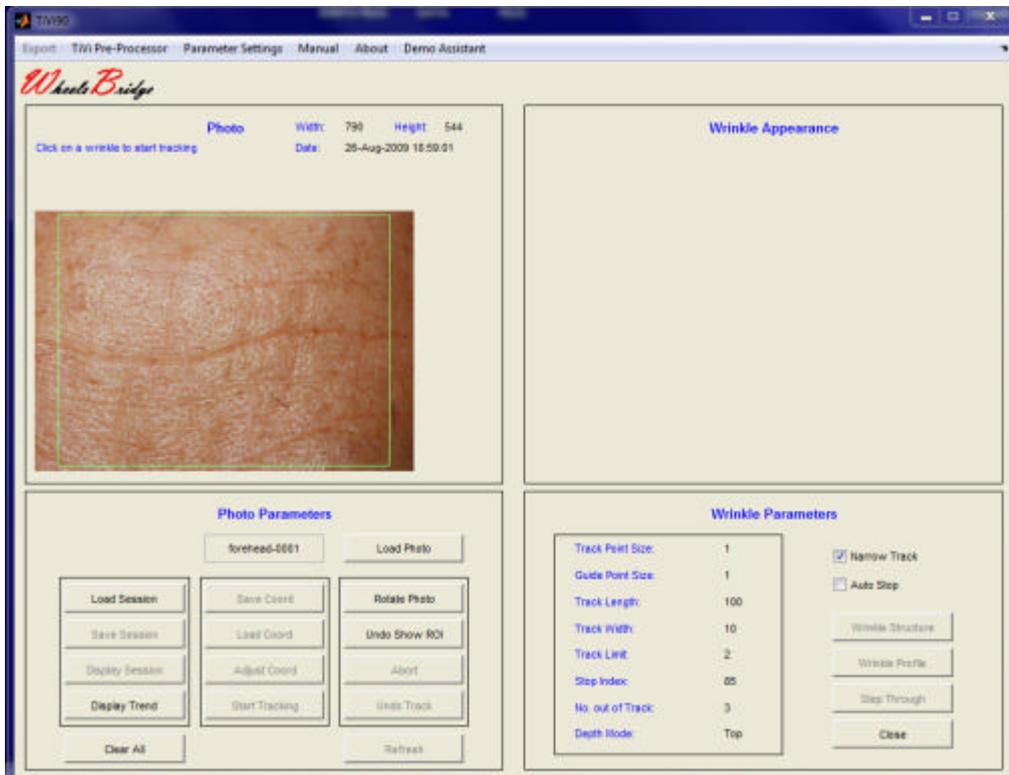


5. Draw a **ROI** as outlined in the figure below by use of the mouse (position the pointer at the upper left corner of the **ROI** to be drawn, press the left mouse button and drag the pointer to the lower right corner – release the left mouse button). The TiVi90 main window should now look like:

TiVi90 Wrinkle Analyzer

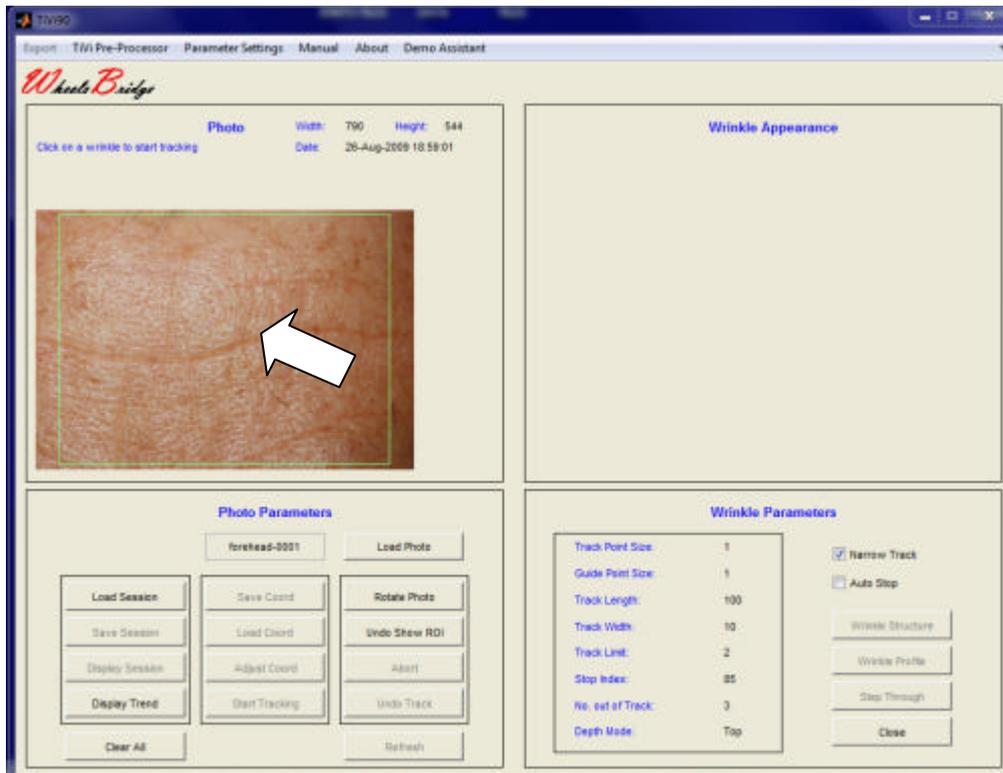


6. Click the **Show ROI** button to display the ROI.



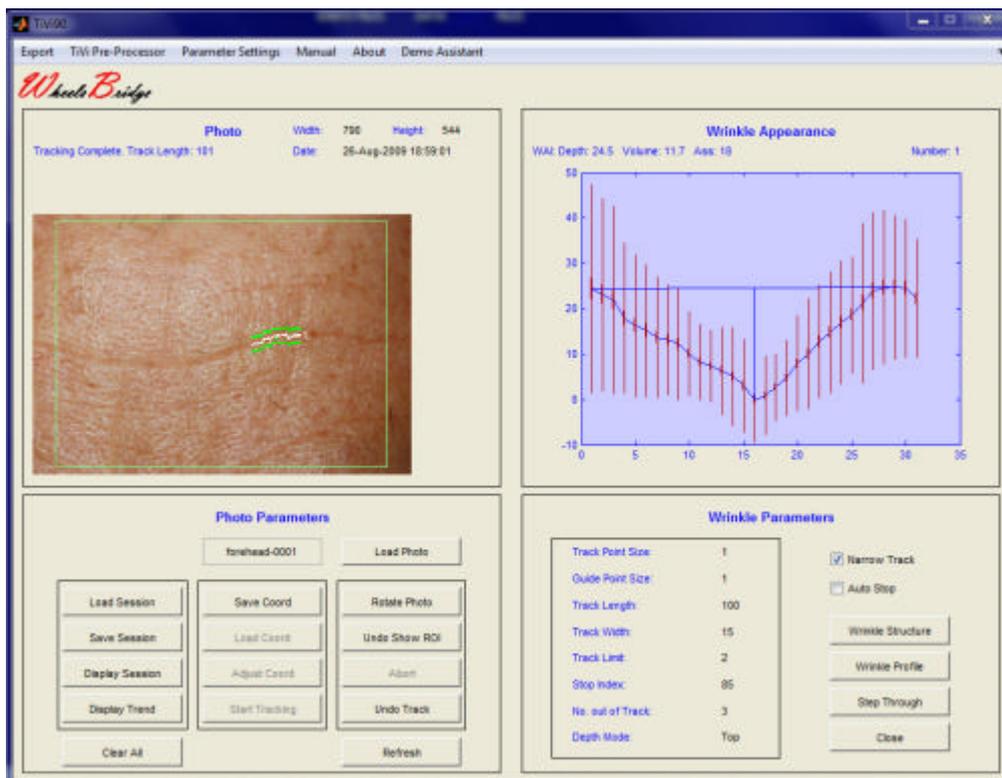
TiVi90 Wrinkle Analyzer

- Control that the **Narrow Track** check-box in the main window is checked and that the **Auto Stop** check-box is unchecked.
- Position the mouse pointer on or in the immediate vicinity of the wrinkle in the upper-right section of the photo and click the left mouse button to start the tracking procedure.

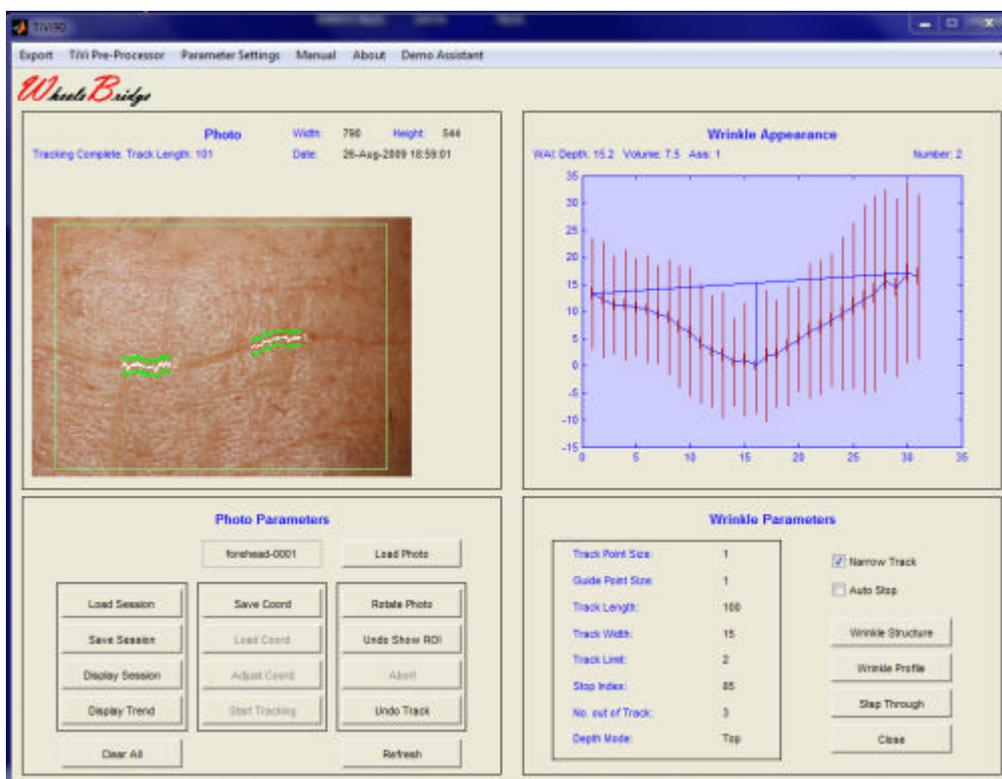


- The system will first track the wrinkle to the right of the mouse pointer and then to the left of the mouse pointer. When the track is complete, it is assigned a number and the average profile is displayed in the **Wrinkle Appearance** window. The **Wrinkle Appearance Index (WAI)** indicates a depth of 19.2, a volume of 7.7 and an asymmetry of -2. The length of the entire track with the actual setting is 100 pixels. The width within which the tracking is performed is 10 pixels (counted up and down from the track-line) as indicated by the green guide-point lines.

TiVi90 Wrinkle Analyzer

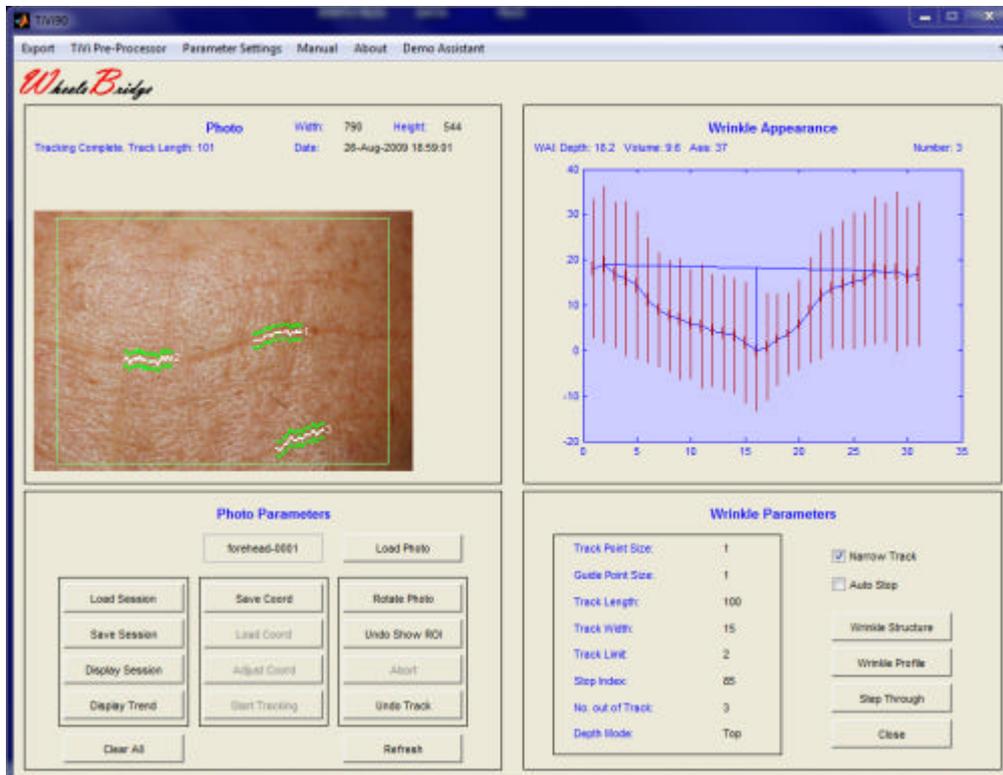


10. Place the mouse pointer to the left of the first track on the same wrinkle and click the left mouse button. The system now tracks the second wrinkle section in this photo. The window should look like:



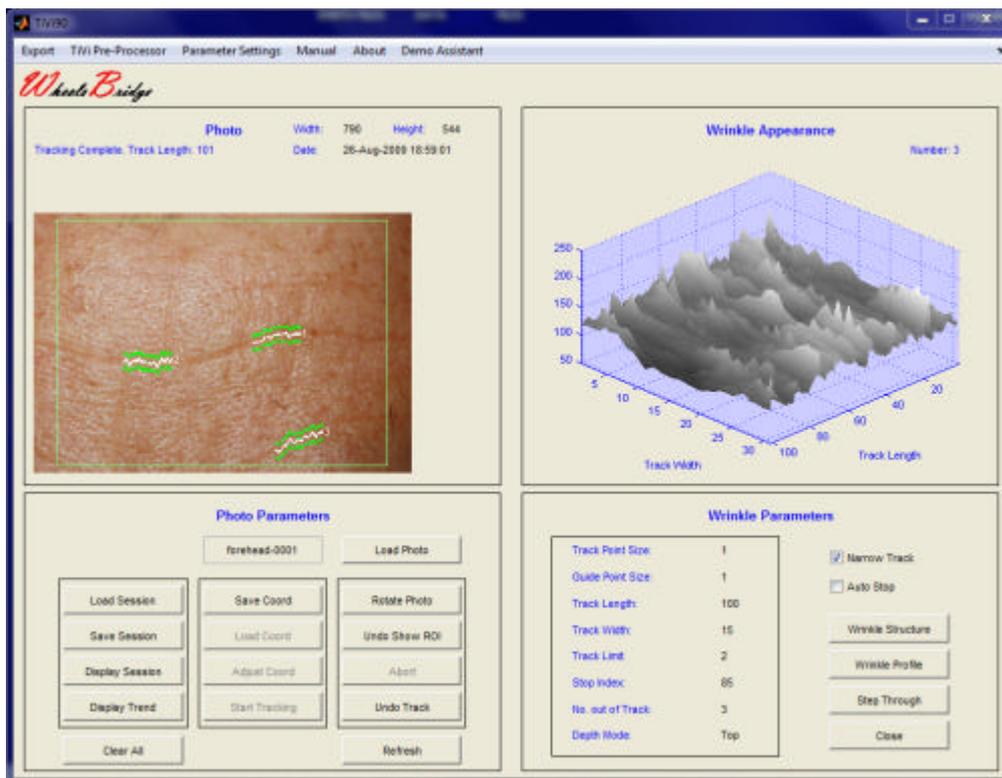
TiVi90 Wrinkle Analyzer

- Place the mouse pointer on the wrinkle in the lower right section of the photo. The system now tracks the third wrinkle segment in this photo. The window should look like:



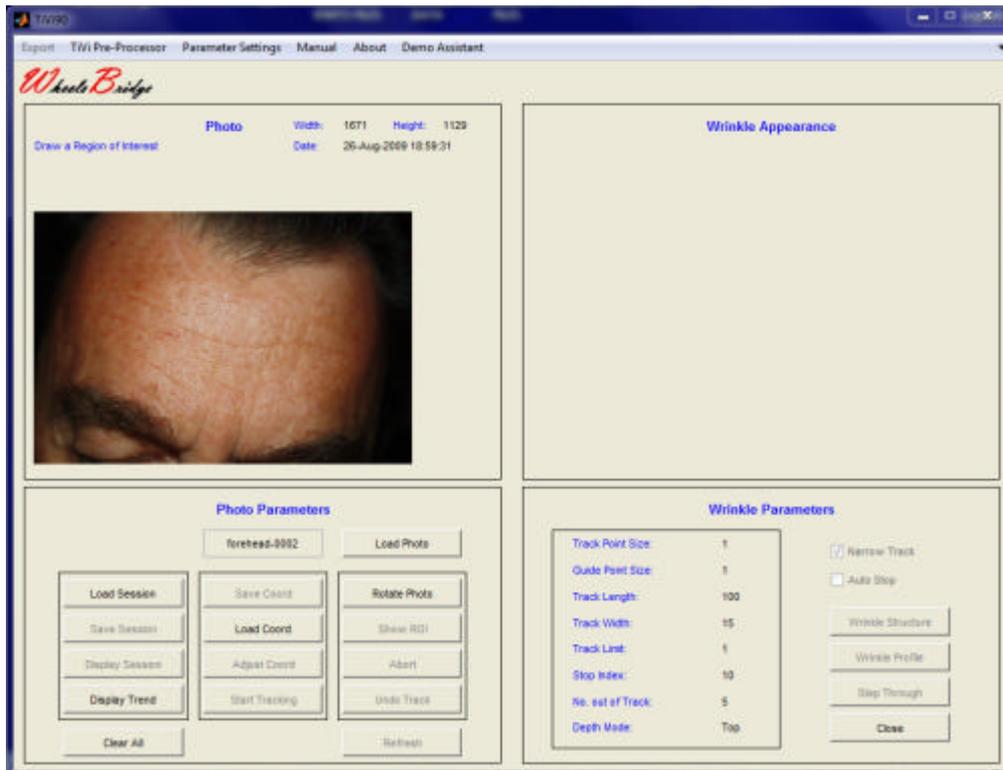
- Click the **Step Through** button in the **Wrinkle Parameters** panel three times to successively display the average profiles of the three tracks. The associated **WAIs** (Depth, Volume and Ass) are displayed in the **Wrinkle Appearance** frame above the profile display. Click the **Wrinkle Structure** button to display the structure of the wrinkle along the tracking area. The **Wrinkle Structure** can be rotated by placing the mouse pointer within the wrinkle structure diagram and pressing the left mouse button.

TiVi90 Wrinkle Analyzer



13. Click the **Step Through** button three times to display the wrinkle structures of the three tracks.
14. Click the **Wrinkle Profile** button to again display the profile.
15. Click the **Save Session** button. Navigate to the *TiVi90demonstration* folder. Print *Assess* in the File Name edit box and click the **Save** button to save the session under the name *Assess_TiVi90session*.
16. Click the **Clear All** button to reset the system.
17. Click the **Load Session** button to open the **Pick a File** window. Double-click the *Assess_TiVi90session* file to re-load this session.
18. Click the **Display Session** button to open the *Assess* session in a separate window. Move this window to the side – it will be used as a reference window for placing the mouse pointer at the same wrinkles in other photos.
19. Click **Load Photo** to load a new photo. Double-click the *forehead-002* file to load this photo.

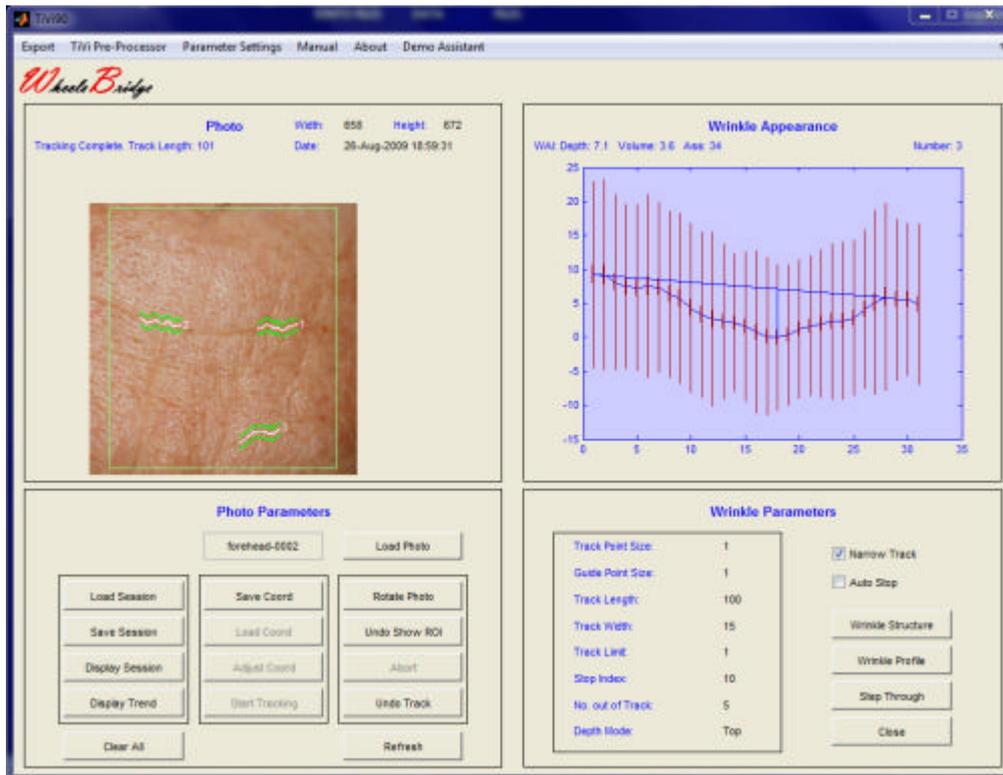
TiVi90 Wrinkle Analyzer



20. Draw a **ROI** around the area of interest (try to select the region of interest to be as similar to that one in the first photo as possible) and click the **Show ROI** button.

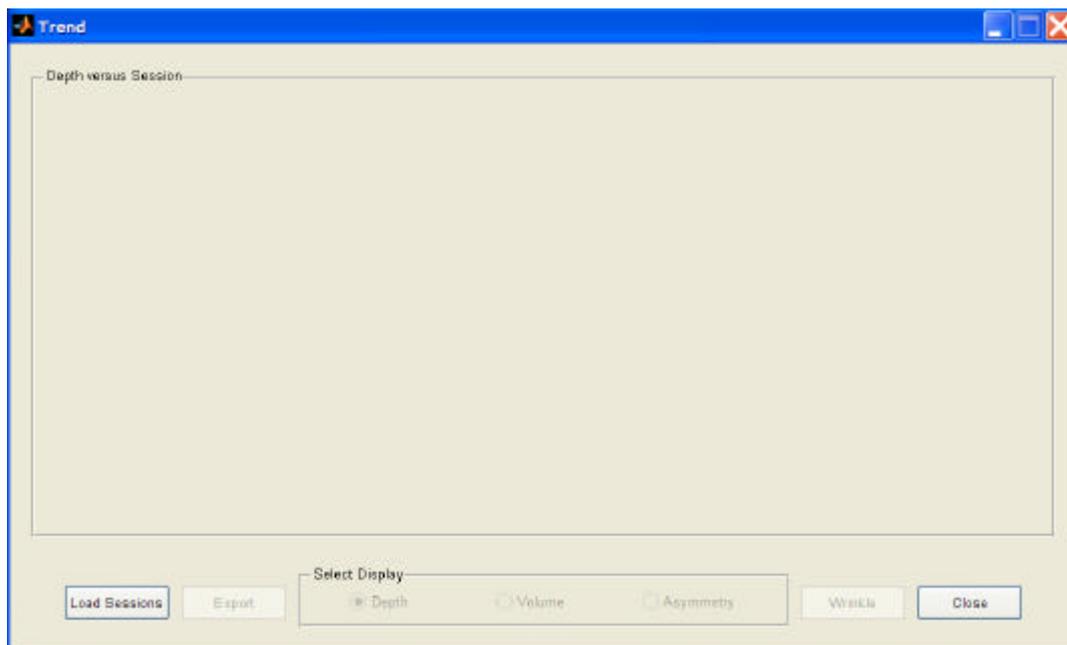
21. Use the green dots in the centre of the tracks in the *Session Display:forehead- 0001* window as reference points and other landmarks in this photo to place the mouse pointers in the same positions on the wrinkles in the *forehead-0002* photo, in the same order as in the first photo. After having generated all three tracks the main window should look like:

TiVi90 Wrinkle Analyzer



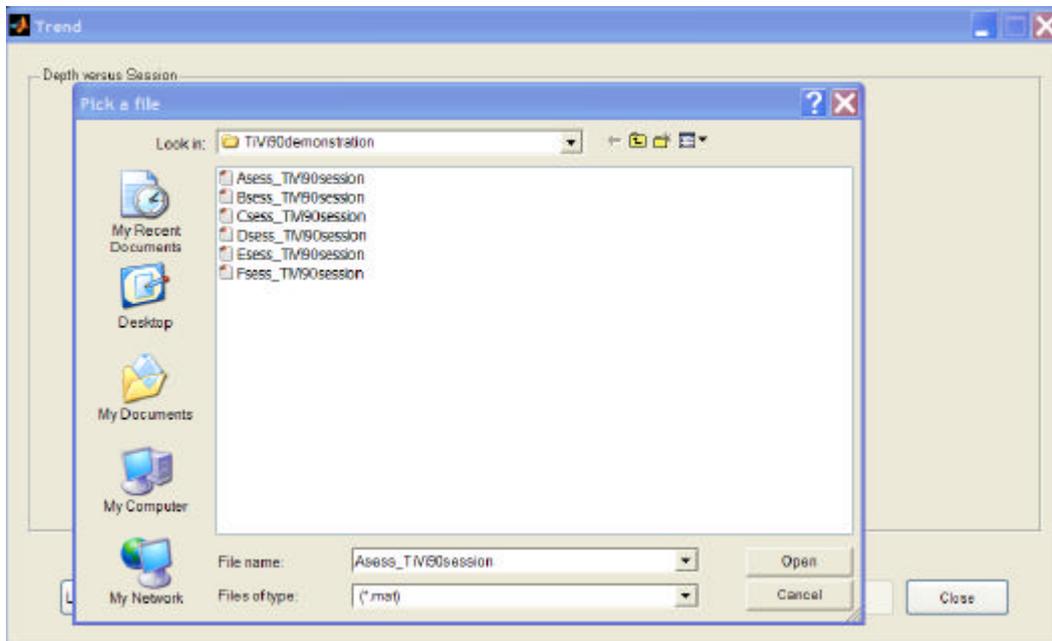
22. Click the **Save Session** button and save this session under name *Bsess*. Continue this procedure with the remaining photos *forehead-003* – *forehead-006* and save the corresponding sessions under the names *Csess*, *Dsess*, *Esess* and *Fsess* in the *TiVi90demonstration* folder. In case a mouse point is misplaced, the corresponding track can be deleted by clicking the **Undo Track** button.

23. Click **Display Trend** to open the **Trend** window.

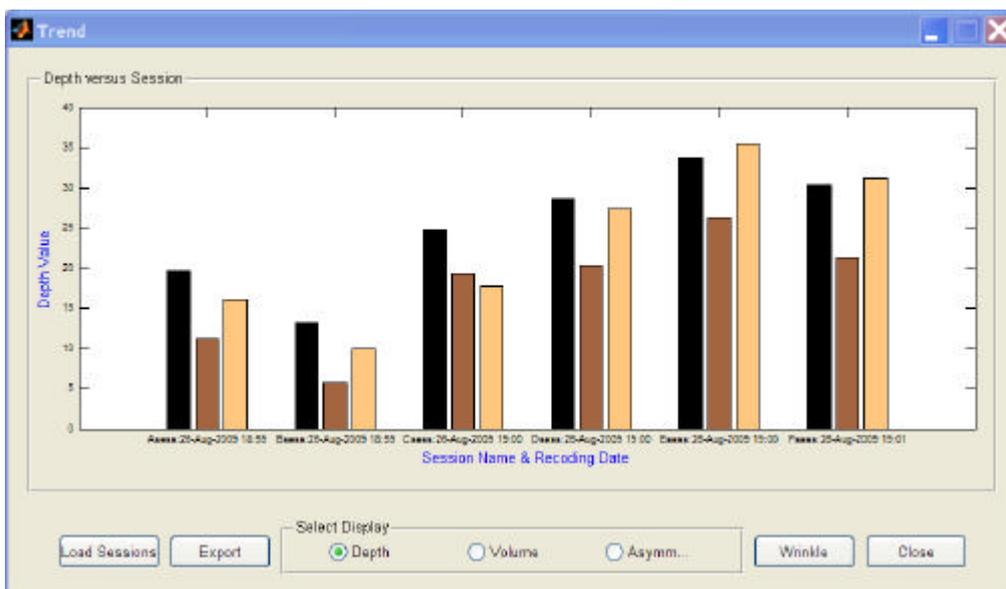


TiVi90 Wrinkle Analyzer

24. Click the **Load Session** button to open the **Pick a File window** and load sessions from the disk.



25. Several sessions can be loaded simultaneously. If all sessions are to be loaded, point at the first session *Asess_TiVi90session* with the mouse. Press the shift-button on the key-board while dragging the mouse to point at the last session *Fsess_TiVi90session*. All files are now high-lighted. Click **Open** to upload the sessions. Alternatively, separate files can be selected by clicking the actual file names while pressing the **Ctrl**-button on the key-board. The **Trend** window should now look like:

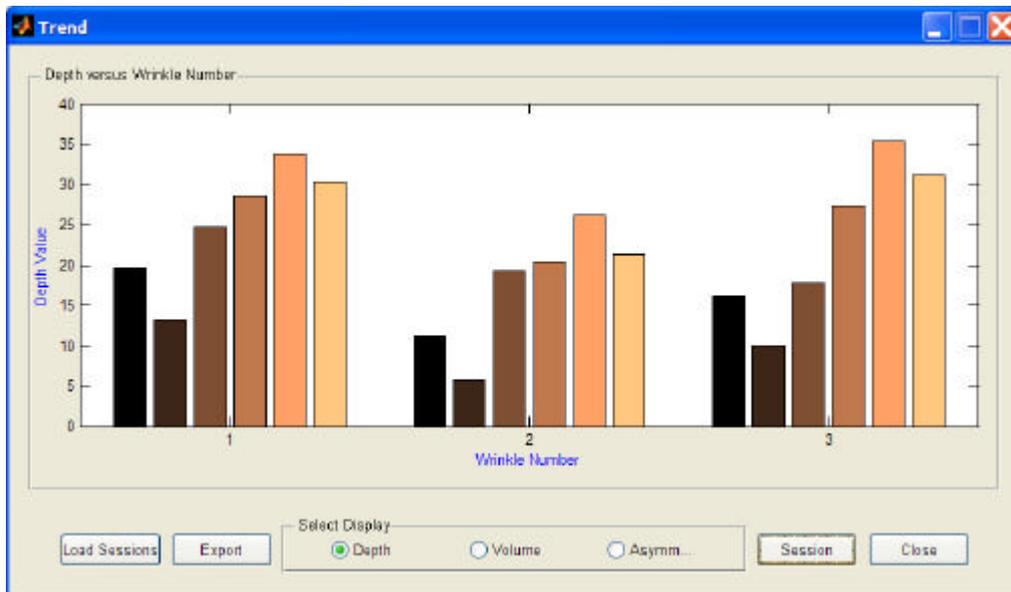


26. The diagram displays the Depth of the selected wrinkles (black = wrinkle No. 1, brown = wrinkle No. 2 and orange = wrinkle No. 3) for the different sessions. The name and dates at which the original photos were captured are displayed along the x

TiVi90 Wrinkle Analyzer

axes for the actual sessions. For all wrinkles analyzed the trend is towards a greater depth with increased frowning.

27. Click the **Wrinkle** button to display the Depth values versus wrinkle number along the x-axes.



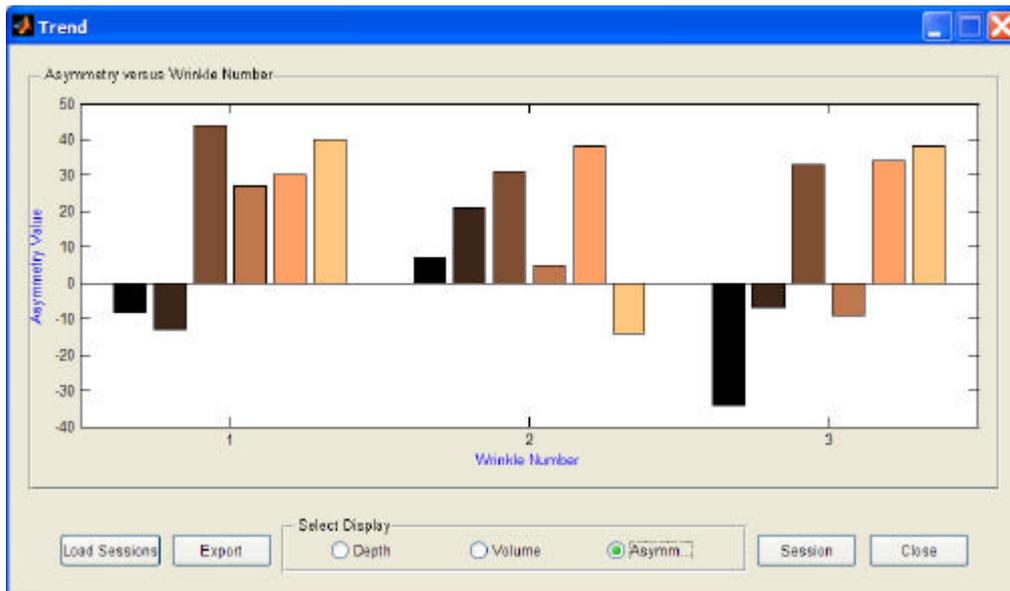
28. Again it can be clearly seen that the **Depth** of each wrinkle increases with session number and increasing forehead frowning.

29. Click the **Volume** radio-button to display the corresponding Volume values.



30. Click the **Asymmetry** radio-button to display the corresponding Asymmetry values.

TiVi90 Wrinkle Analyzer

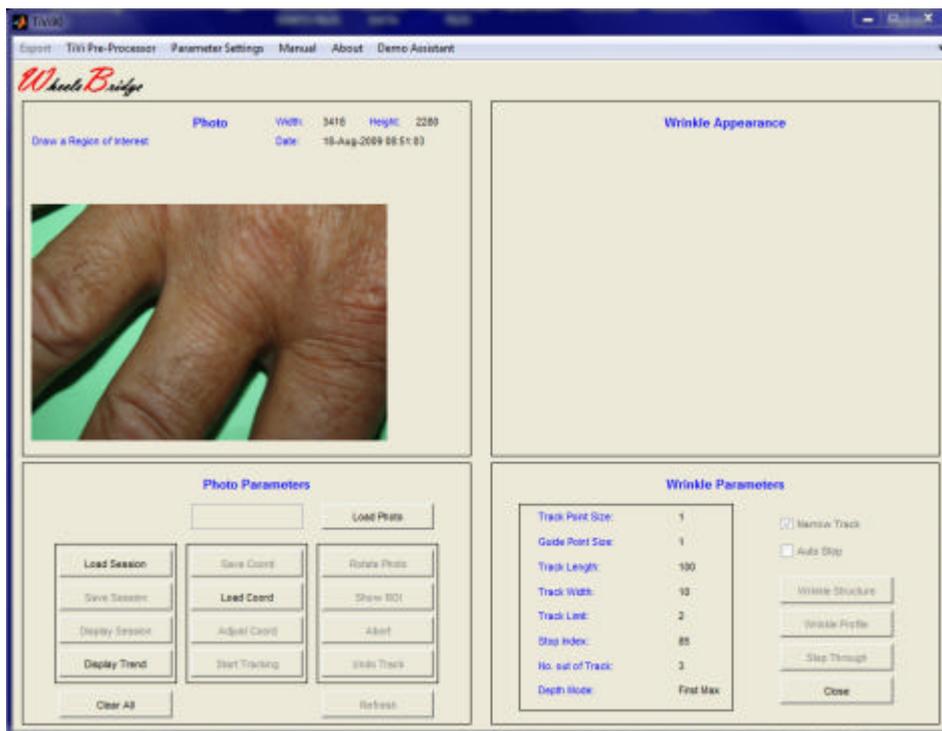


31. Click the **Export** button menu and navigate to a folder into which the **Trend** data is to be stored in MS Excel ASCII format. Insert a **File Name** in the **File Name** edit box in the **Save As** window and click the **Save** button.
32. Click the **Close** button to close the **Trend** window.
33. Navigate to the folder in which the MS Excel spread sheet was saved and double-click its name. If MS Excel is installed the spread sheet will now open. This spread sheet contains numerical information about the Wrinkle characteristics that can be used for further analysis.

A further example demonstrates the possibility to analyze also the minutest wrinkles on the back of the hand. It is assumed that the photos are captured with the polarization filters set to co-polarization mode.

1. Open the **TiVi90 Wrinkle Analyzer** main menu.
2. Click the **Load Photo** button and select the *Hand-0001* file in the *TiVi90demonstration* folder. The main window should now look like:

TiVi90 Wrinkle Analyzer

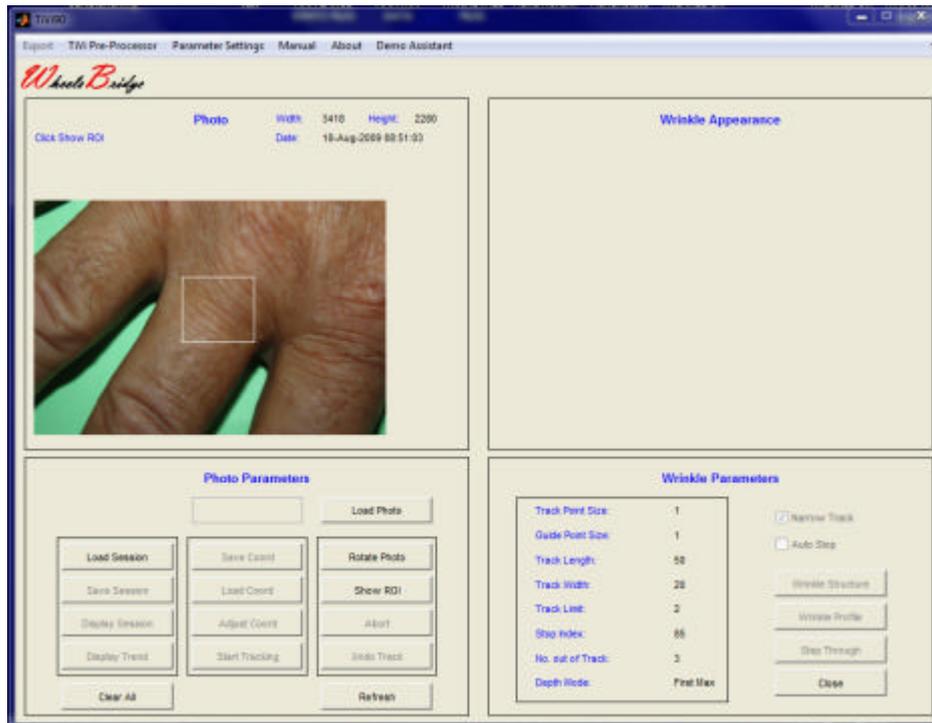


3. Open the **Parameter Settings** window and set the parameters in accordance with the figure below.

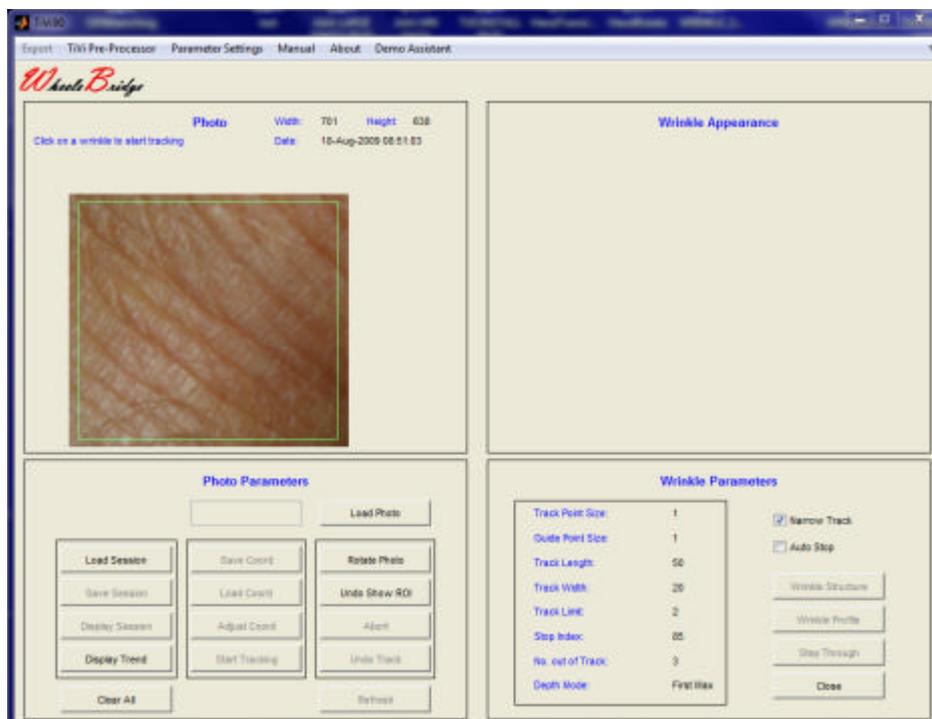


4. Observe that the **Track Length** has been set to 50 and the **Track Width** to 20. Click the **OK** button to accept the parameters and close the **Parameter Settings** window.
5. Draw a **ROI** over the base of a finger.

TiVi90 Wrinkle Analyzer

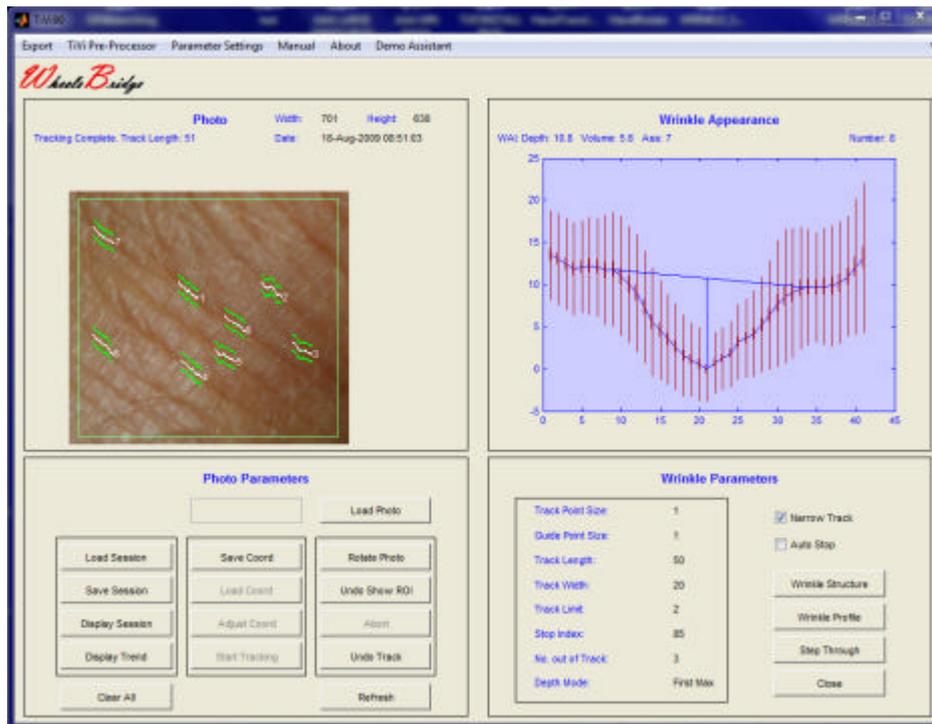


6. Click the **Show ROI** button.

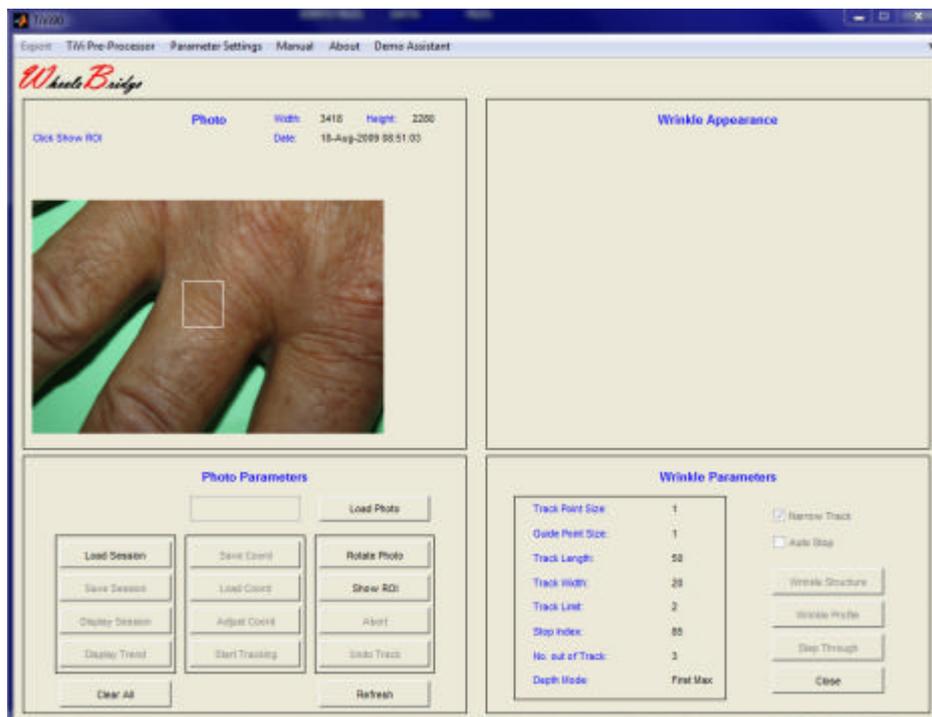


7. We will start by analyzing the horizontal major wrinkles and then continue with rotating the photo to analyze the minor wrinkles. Produce 8 tracks by placing the mouse pointer at the centre of the actual wrinkles.

TiVi90 Wrinkle Analyzer

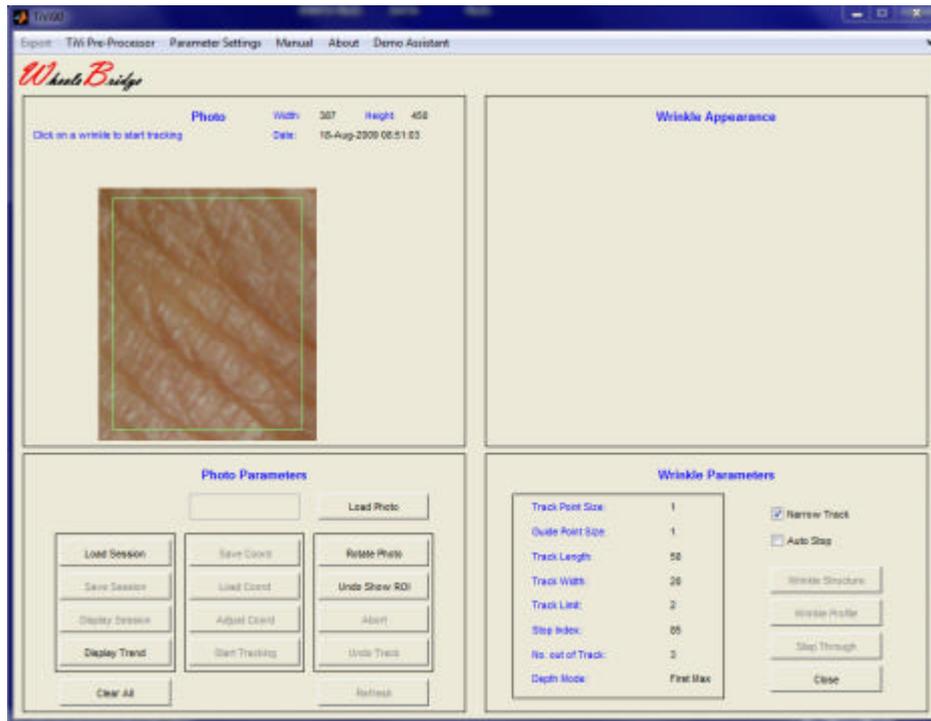


8. Click the **Save Session** button and save the session under name *HandA*.
9. Set **Track Length** to 20 and **Track Width** to 10 in the **Parameter Settings** window.
10. Click **Undo Show ROI** and draw a smaller **ROI** in the photo.



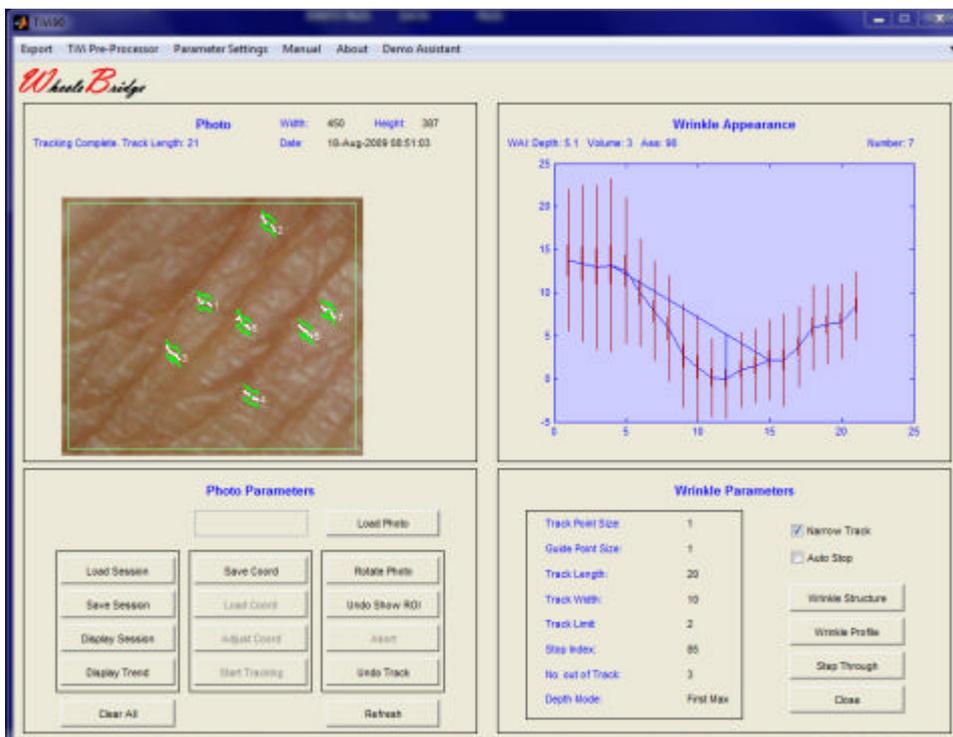
11. Click the **Show ROI** button.

TiVi90 Wrinkle Analyzer



12. Click the **Rotate Photo** once to rotate the photo 90 degrees and get the finest wrinkles in parallel with the scanning direction.

13. Produce tracks of the finest wrinkles by placing the mouse pointer at the centre of the finest wrinkles after having set the parameters.



TiVi90 Wrinkle Analyzer

14. Save the session under the name *HandB*.
15. Click the **Display Trend** button to open the **Trend** window and load the two sessions.



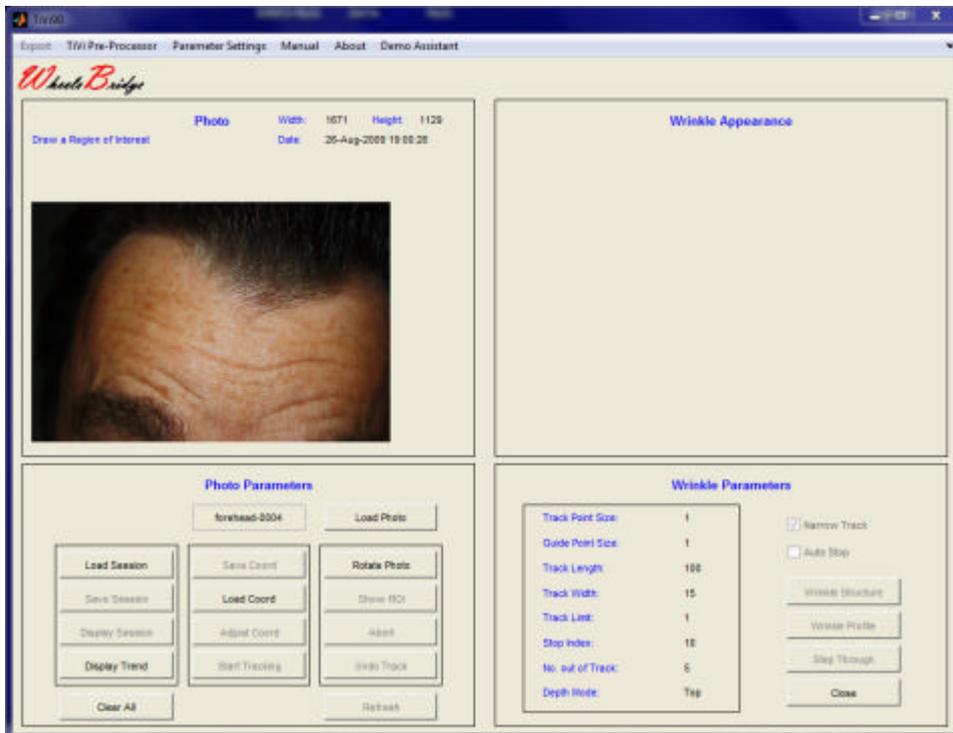
16. The rightmost group of bars represents the finest wrinkles while the leftmost group of bars represents the somewhat larger wrinkles in the skin at the base of the finger. Click the **Volume** radio-button to display the **Volume** of the two sets of wrinkles.



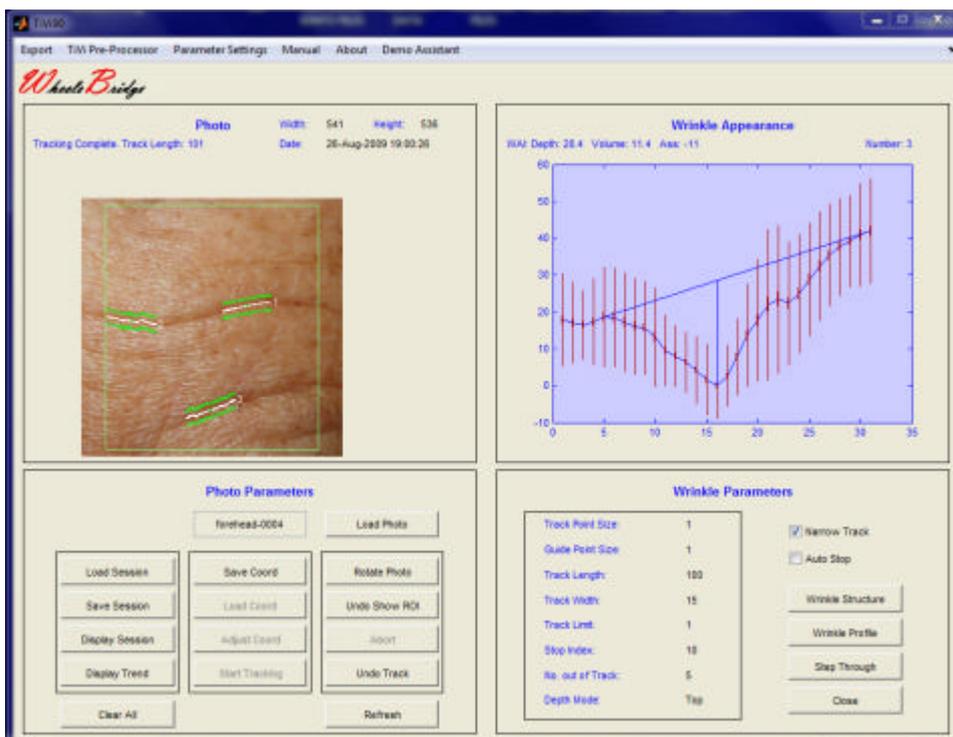
The final example demonstrates the possibility to save and reload the coordinates for a wrinkle session which is useful when two sessions recorded at different points in time are to be compared.

TiVi90 Wrinkle Analyzer

1. Open the **TiVi90 Wrinkle Analyzer** main menu.
2. Click the **Load Photo** button and select the *forehead_0004* file in the *TiVi90demonstration* folder. The main window should now look like:

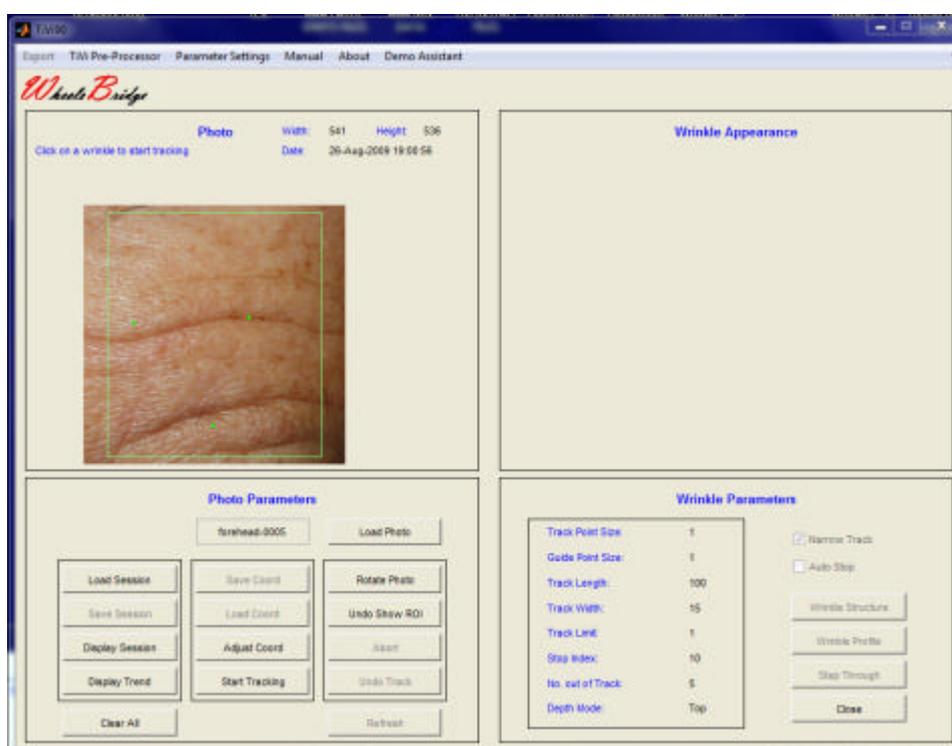


3. Draw a region of interest, click **Show ROI** and produce three tracks. The main window should now look like:



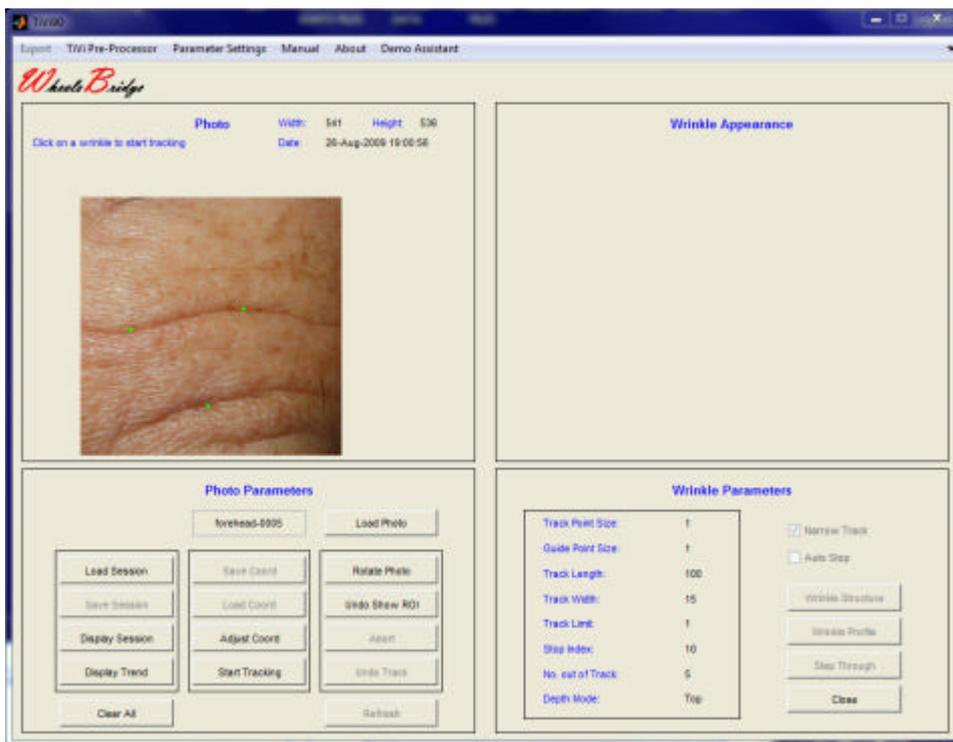
TiVi90 Wrinkle Analyzer

4. Click the **Save Coord** button to save the centre coordinates of the three tracks and the associated ROI. Navigate to a folder in which these parameters are to be saved, insert a name (*MyCoord*) in the **File Name** text box and click the **Save** button.
5. Click **Display Session** to display the results in a separate window.
6. Click the **Clear All** button and load the photo *forehead-0005*.
7. Click the **Load Coord** button and navigate to the folder in which the coordinates for the tracks in *forehead-0004* were saved. Double-click *MyCoord_TiVi90tracks.mat*. The main window should now look like:



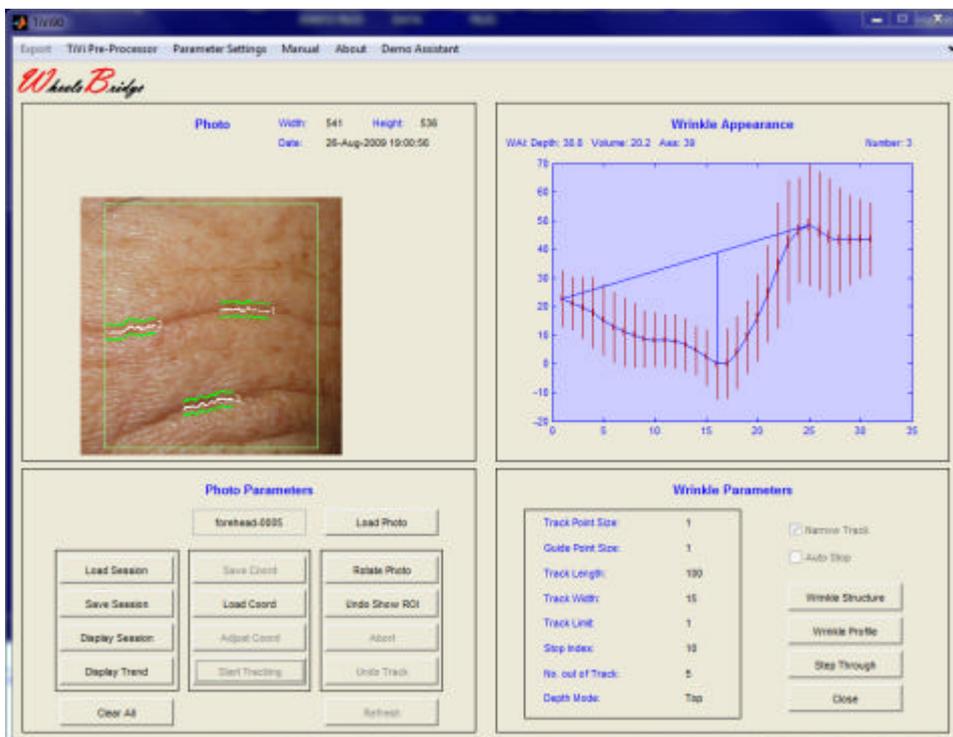
8. The three green dots represent the centre of the middle of the individual tracks in the photo *forehead-0004*. They should be in the vicinity of the corresponding wrinkles in the photo *forehead-0005* now displayed.
9. To move the green dots closer to the respective wrinkle point on a green dot, press the left mouse button and drag the dot to the final position, where the mouse button is released. Repeat this procedure for all three green dots. The main window should now look like:

TiVi90 Wrinkle Analyzer



10. To make the final adjustment of the green dot positions, click the **Adjust Coord** button.

11. Click **Start Tracking** to produce the tracks in the photo displayed. The main window should now look like:



12. Click **Display Session** to display the results in a separate window.

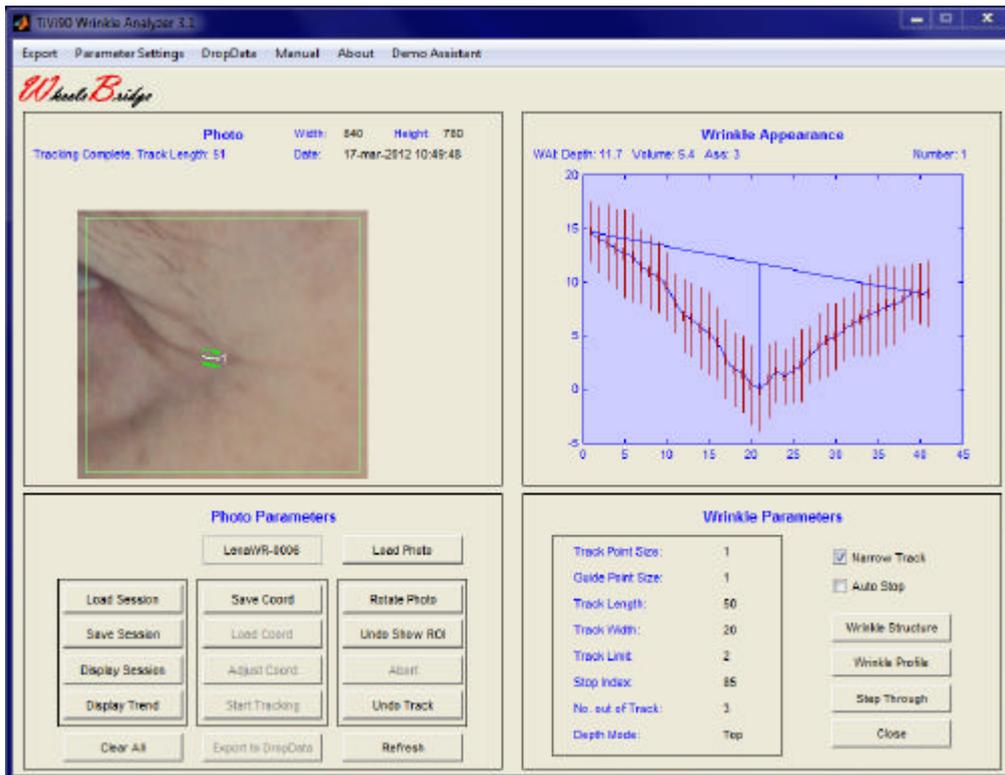
13. The wrinkle profiles in the photos *forehead-0004* and *forehead-0005* can now be compared.

This concludes the **GETTING STARTED** section.

TiVi90 Wrinkle Analyzer

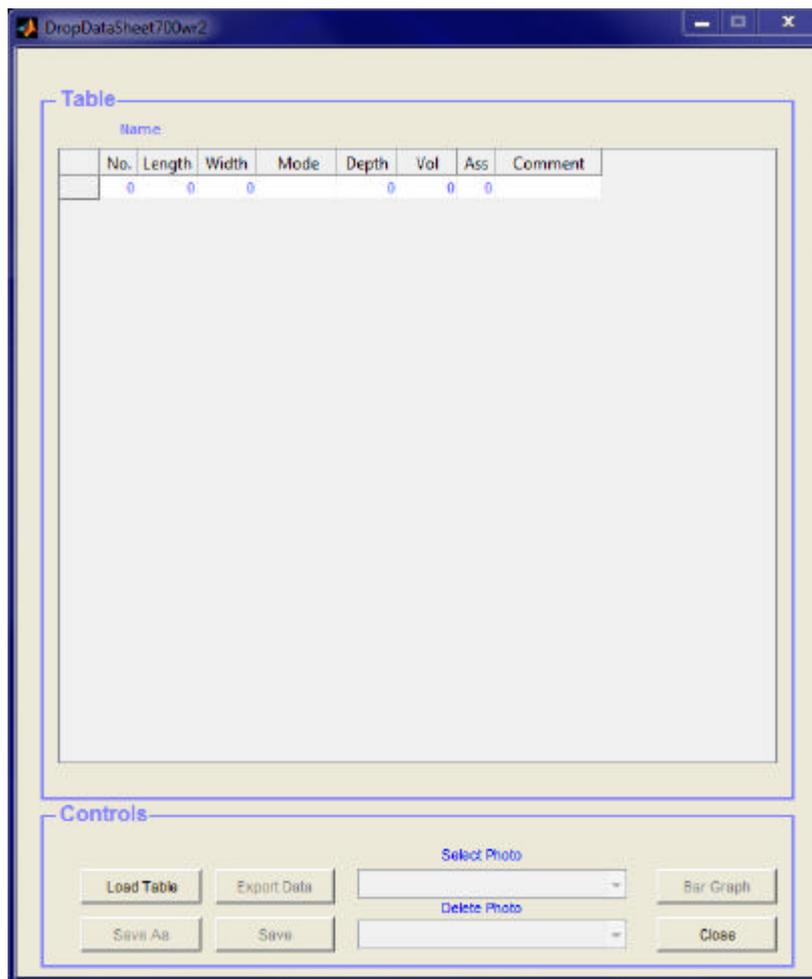
4. DROPDATA

Using **DropData** is a convenient way of bringing image wrinkle data such as Depth, Volume and Asymmetry to a table or Excel spread-sheet. Assume that a wrinkle in a photo has been tracked and the *TiVi90 Wrinkle Analyzer* window looks like:



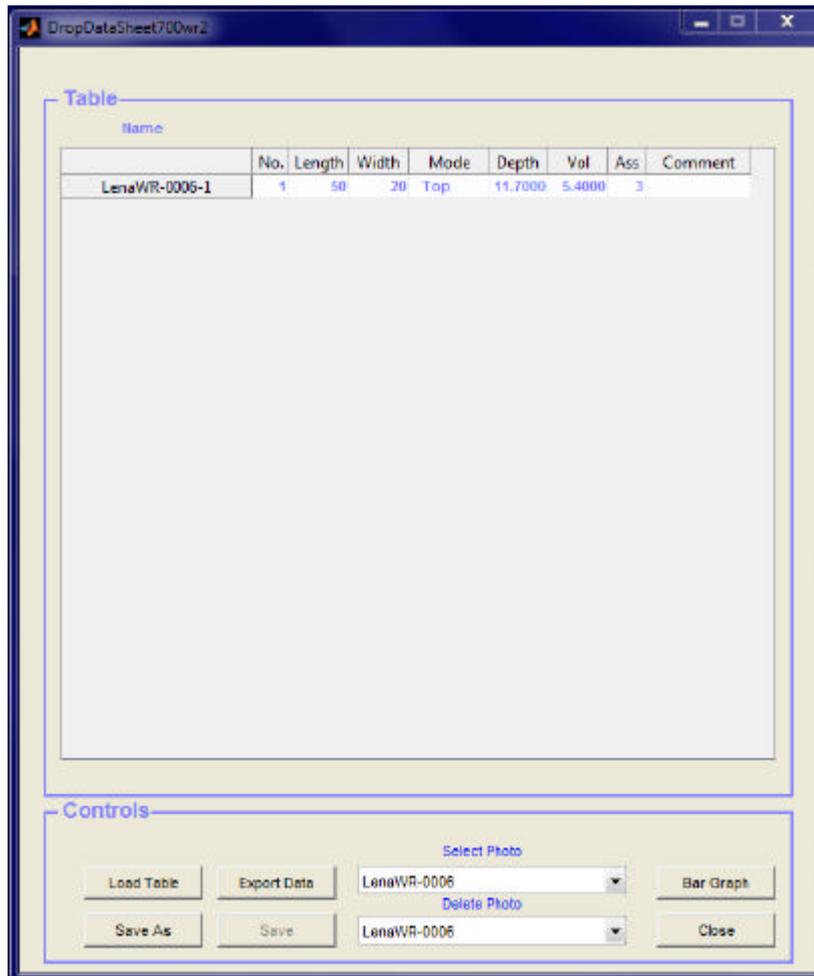
1. Select **DropData** in the pull-down menu to open the **DropDataSheet**.

TiVi90 Wrinkle Analyzer



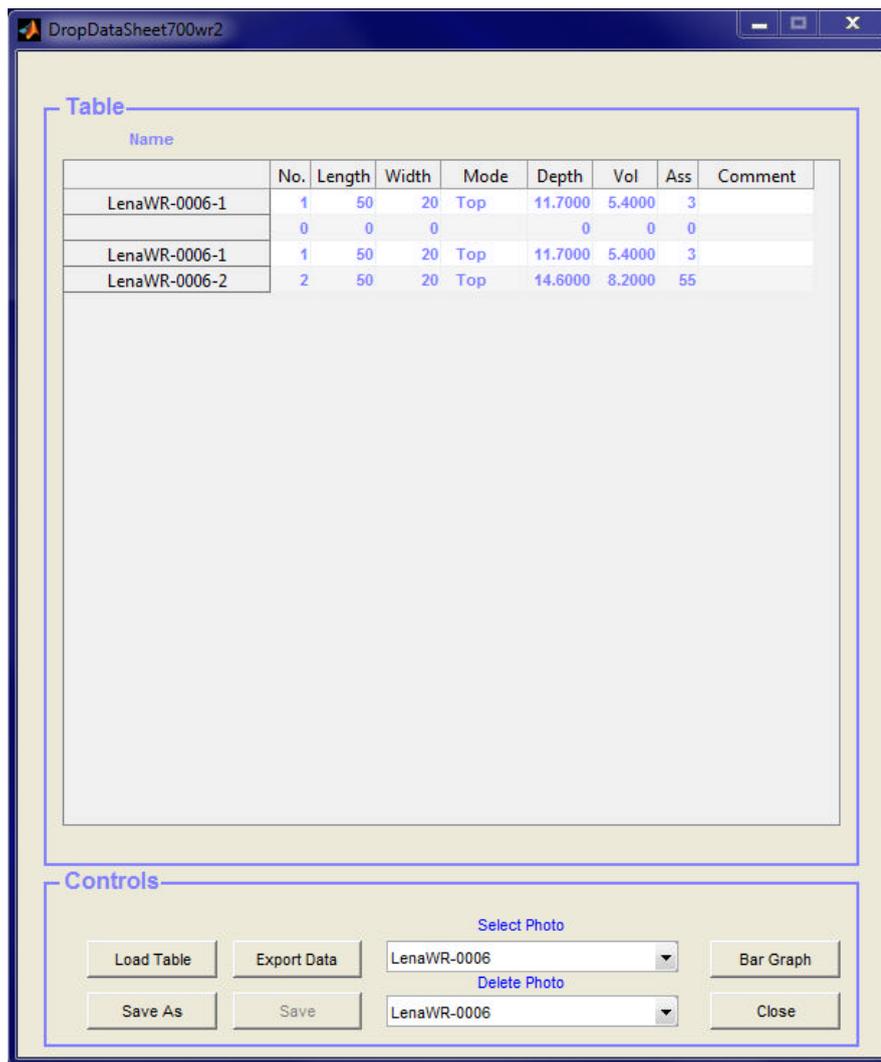
2. Click the **Export to Dropdata** button in the *TiVi Wrinkle Analyzer* window. The wrinkle data now appears in the first row in the DropData window.

TiVi90 Wrinkle Analyzer



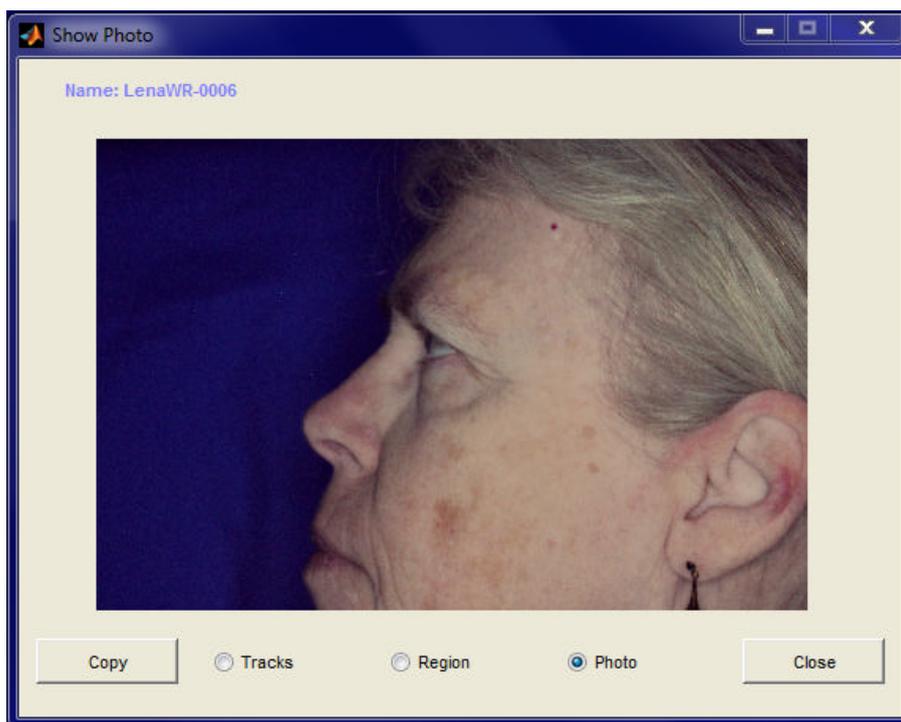
3. Track a new wrinkle and again click the **Export to DropData** button. New wrinkle information is now added to the *DropDataSheet* table.

TiVi90 Wrinkle Analyzer

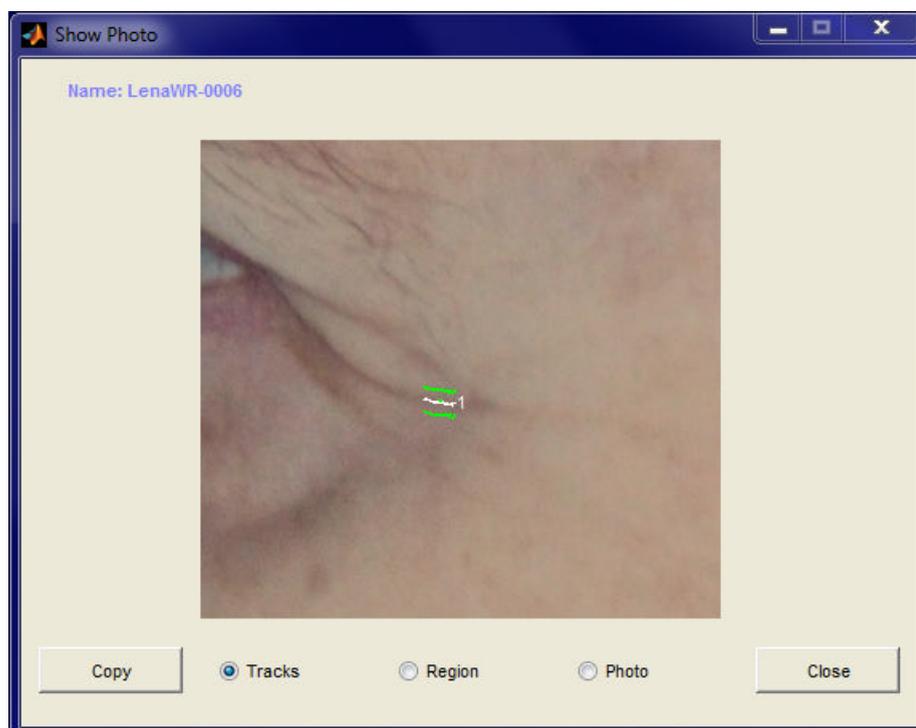


4. Upload a new photo in the *TiVi Wrinkle Analyzer* window.
5. In order to place the wrinkle center coordinates at the same position in this photo, select the first *LenaWR-0006* photo from the **Select Photo** menu in the **DropData** window to open the **Show Photo** window:

TiVi90 Wrinkle Analyzer

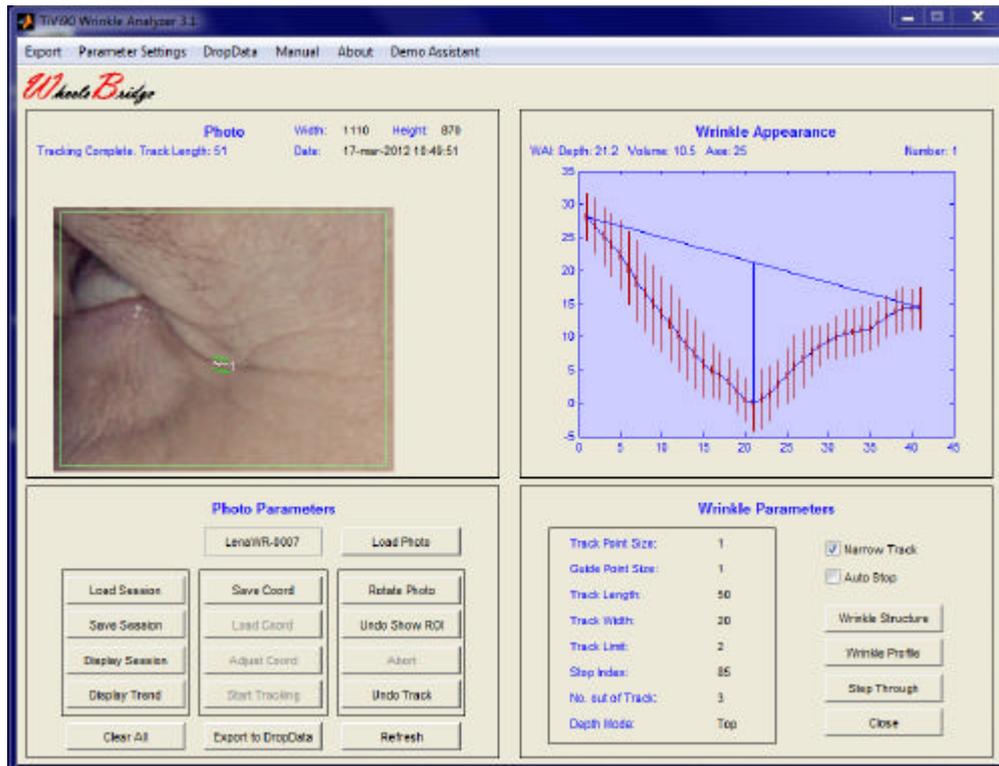


6. Click the **Tracks** radio-button to display this photo with tracks drawn.



7. This window with center coordinates of wrinkles in the photo *LenaWR-0006* can now be used as a guide to set the tracker coordinates in the actual photo displayed in the *TiVi Wrinkle Analyzer* window.

TiVi90 Wrinkle Analyzer



8. Click the **Export to DropData** button to export the wrinkles data from this new photo to the **DropData** table which now should look like:

TiVi90 Wrinkle Analyzer

The screenshot shows a software window titled "DropDataSheet700wr2". Inside, there is a "Table" section with a data table and a "Controls" section with several buttons and dropdown menus.

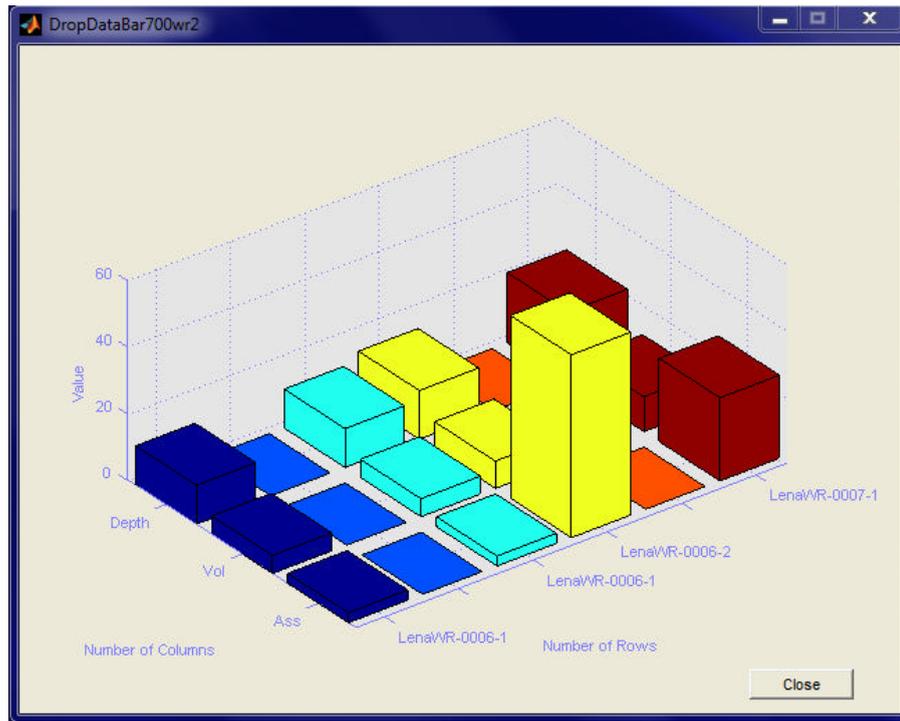
Name	No.	Length	Width	Mode	Depth	Vol	Ass	Comment
LenaWR-0006-1	1	50	20	Top	11.7000	5.4000	3	
	0	0	0		0	0	0	
LenaWR-0006-1	1	50	20	Top	11.7000	5.4000	3	
LenaWR-0006-2	2	50	20	Top	14.6000	8.2000	55	
	0	0	0		0	0	0	
LenaWR-0007-1	1	50	20	Top	21.2000	10.5000	25	

The "Controls" section contains the following elements:

- Buttons: Load Table, Export Data, Save As, Save, Bar Graph, Close.
- Dropdown menus: Select Photo (set to LenaWR-0006), Delete Photo (set to LenaWR-0006).

9. Click **Bar Graph** to display the data in a **Bar Graph** diagram.

TiVi90 Wrinkle Analyzer



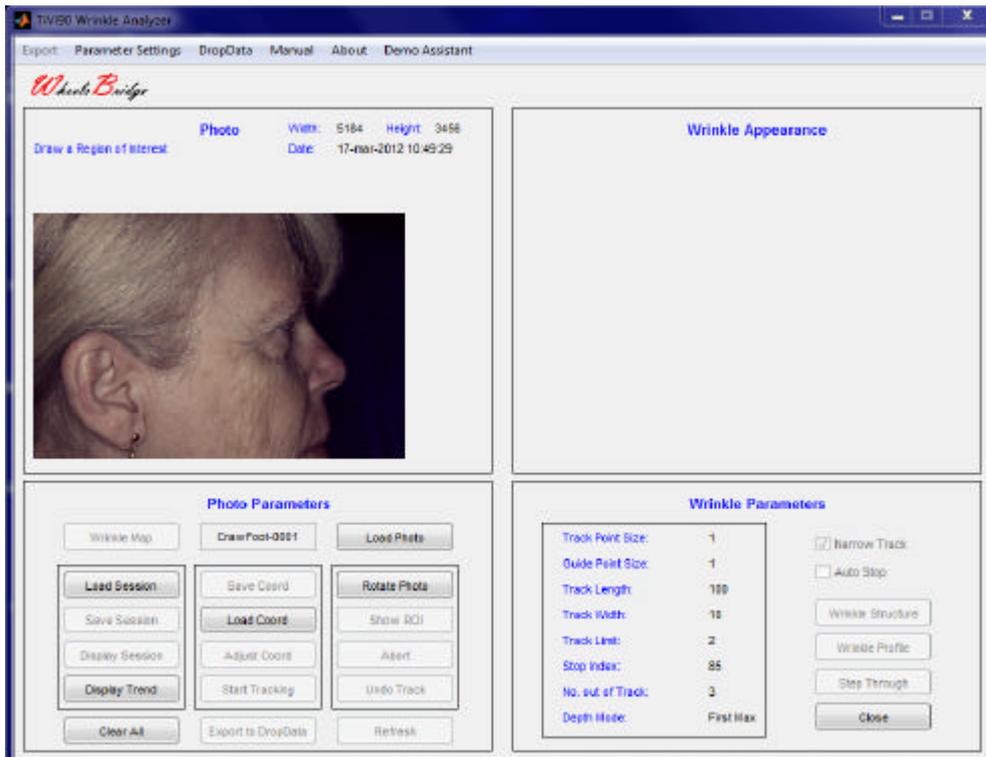
10. Click the **Export Data** button in the **DropData** window to export the wrinkle data to an Excel spread-sheet.
11. Click the **Close** button to close the **DropData** window.

TiVi90 Wrinkle Analyzer

5. WRINKLE MAP

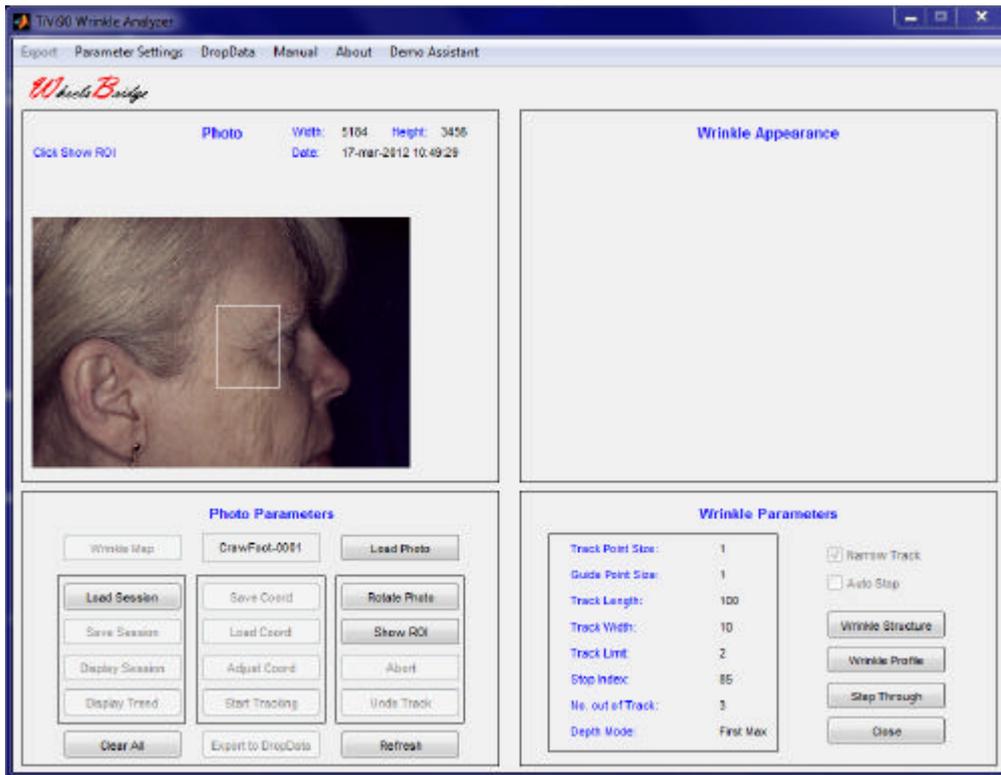
The *Wrinkle Map* is particularly useful for displaying the appearance of a group of adjacent wrinkles such as *craw-foot wrinkles* appearing close to the eye.

1. Click **Load Photo** and upload the *CrawFoot-001* photo from the *TiVi90demonstration* folder.

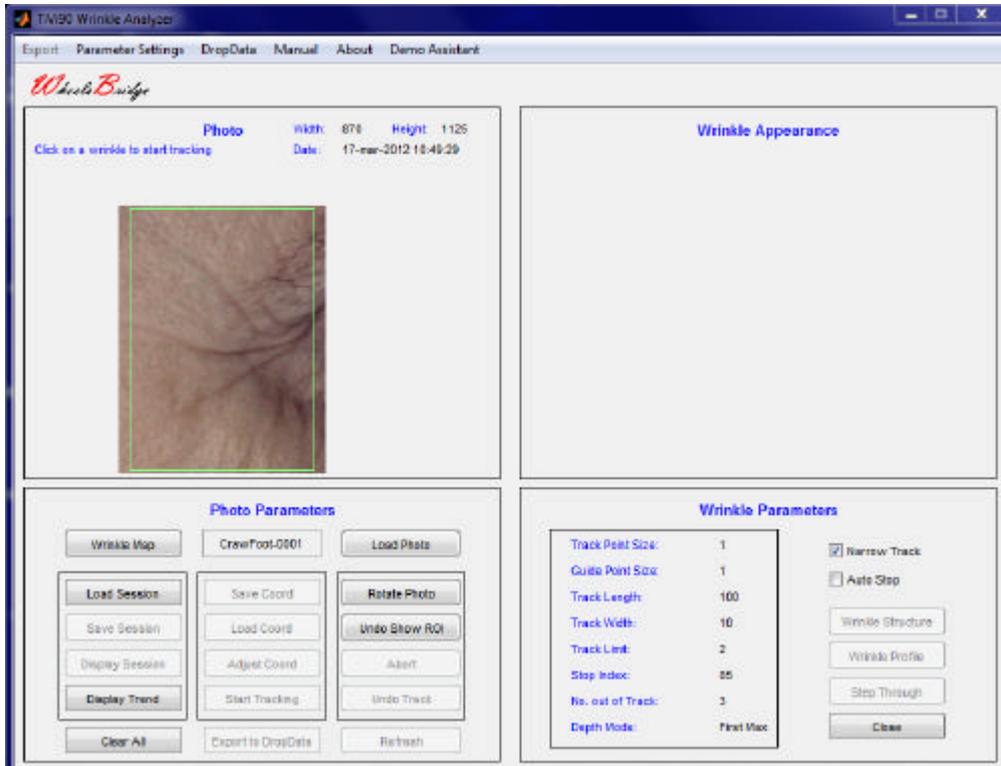


2. Draw a **ROI** around the areas with *craw-foot wrinkles*.

TiVi90 Wrinkle Analyzer



3. Click the **Show ROI** button to display the **ROI** area.



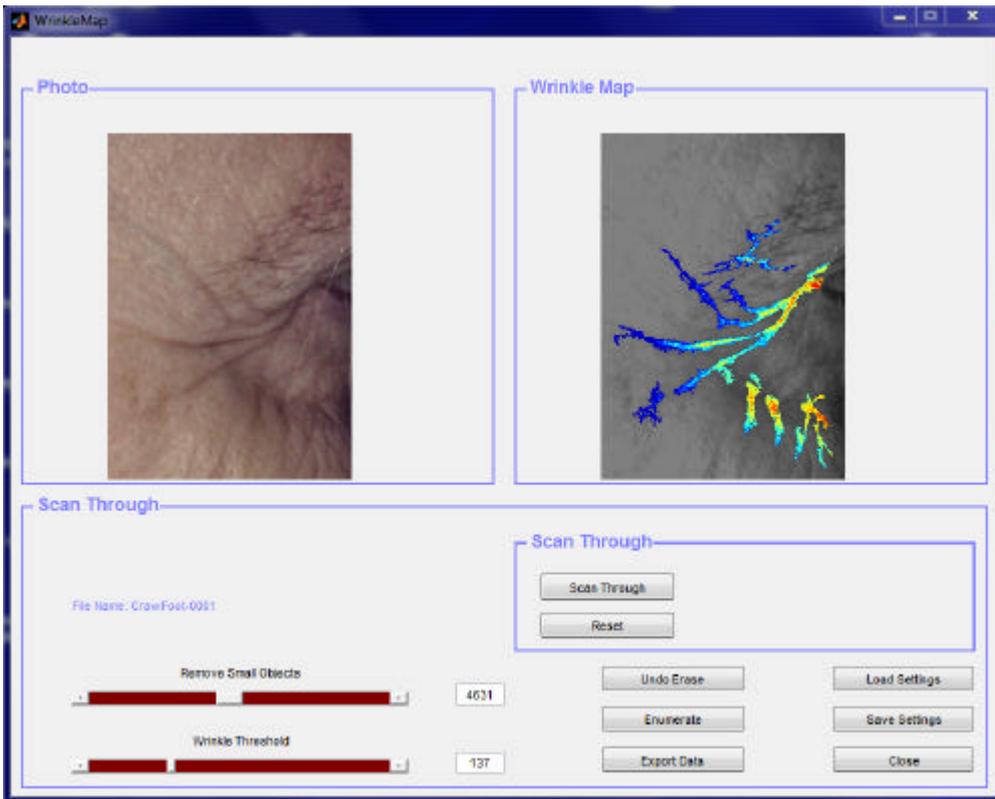
4. Click the **Wrinkle Map** button to open the *Wrinkle Map* window.

TiVi90 Wrinkle Analyzer



5. In the *Wrinkle Map* window a set of wrinkles with a depth determined by the threshold setting in the **Wrinkle Map** panel is displayed.
6. Print 137 in the **Wrinkle Threshold** edit box (or adjust the setting by use of the **Wrinkle Threshold** slider) to change the threshold.

TiVi90 Wrinkle Analyzer

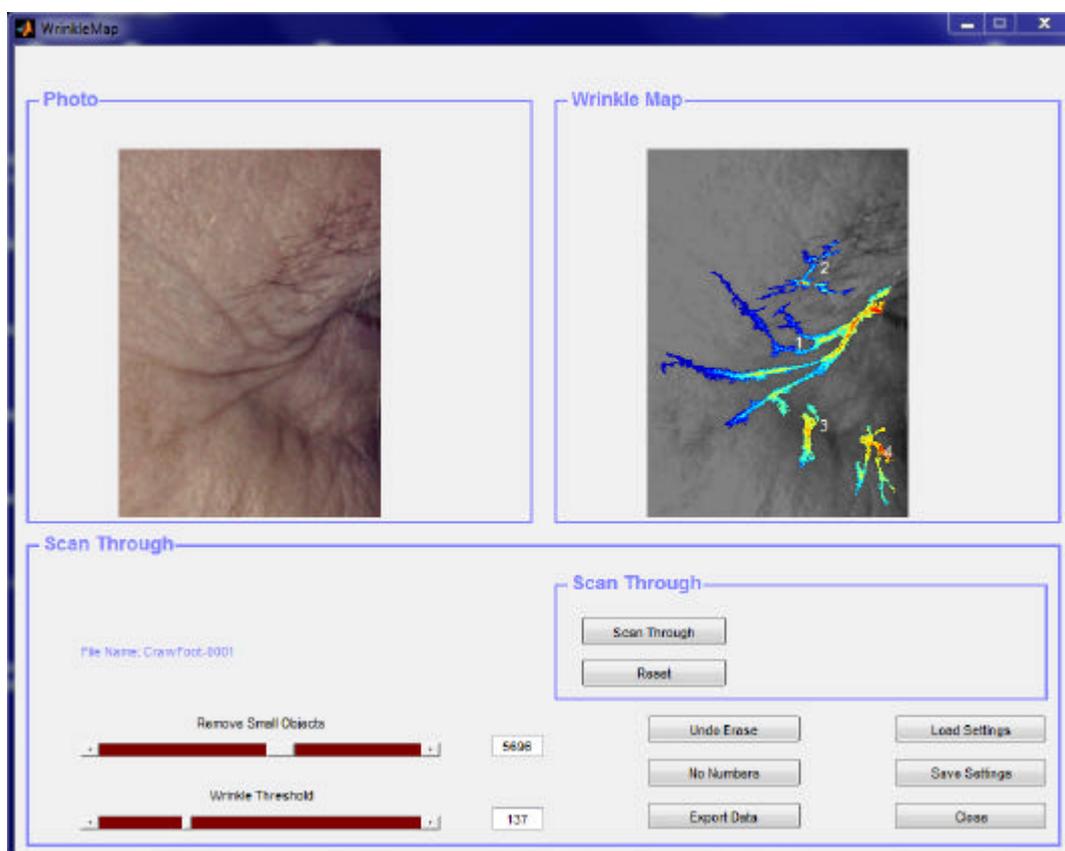


7. Drag the **Remove Small Objects** slider to the right to remove small wrinkle segments from the *Wrinkle Map*.



TiVi90 Wrinkle Analyzer

- Click the **Enumerate** button to assign and display numbers to the individual wrinkle segments.



- Click the **Scan Through** button to display the wrinkle segments one-by-one. The parameters of the actual wrinkle segment will now be displayed in the **Scan Through** panel.

TiVi90 Wrinkle Analyzer



10. Click the **Reset** button. To remove segment 2 (which is part of the eye brow rather than a wrinkle segment) from the *Wrinkle Map*, point at this segment by the mouse pointer, press the left mouse button and drag the mouse pointer to a position outside the *Wrinkle Map* with the mouse button pressed.

TiVi90 Wrinkle Analyzer



11. The remaining wrinkle segments are now renumbered. Click the **Export Data** button and save the information about the wrinkles segments in an **Excel** file.
12. Open the Excel file to display the wrinkle information.

File Name: CrawFoot-0001		
Remove Small Objects: 6967		
Wrinkle Threshold: 139.0192		
Number	Area	Wrinkle Score
1	57772	344
2	18403	270
3	8985	457
4	14799	434

In order to make meaningful comparison of two photos with Craw-foot wrinkles the parameters **Removes Small Objects** and the **Wrinkle Threshold** must have the same settings in both photos.

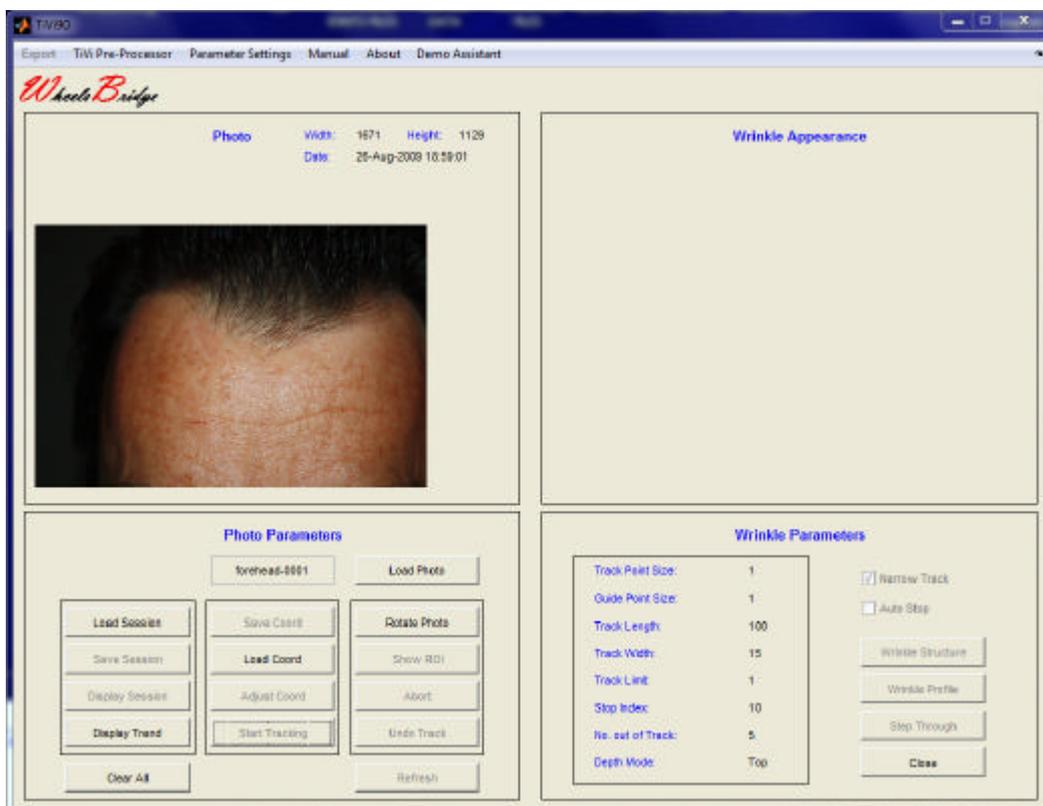
TiVi90 Wrinkle Analyzer

6. DETAILED DESCRIPTION

6.1 Wrinkle Analyzer TiVi90 main window

When the *Wrinkle Analyzer TiVi90* is started in tool-box mode from inside the *TiVi700 Analyzer*, the first photo in the sequence loaded in the *TiVi700* software is automatically transferred to the *Wrinkle Analyzer TiVi90*.

In the *Wrinkle Analyzer TiVi90* window the photo *forehead-0001.jpg* has been uploaded by clicking the **Load Photo** button and then double-clicking the file icon *forehead-0001.jpg* in the *TiVi90demonstration* folder.



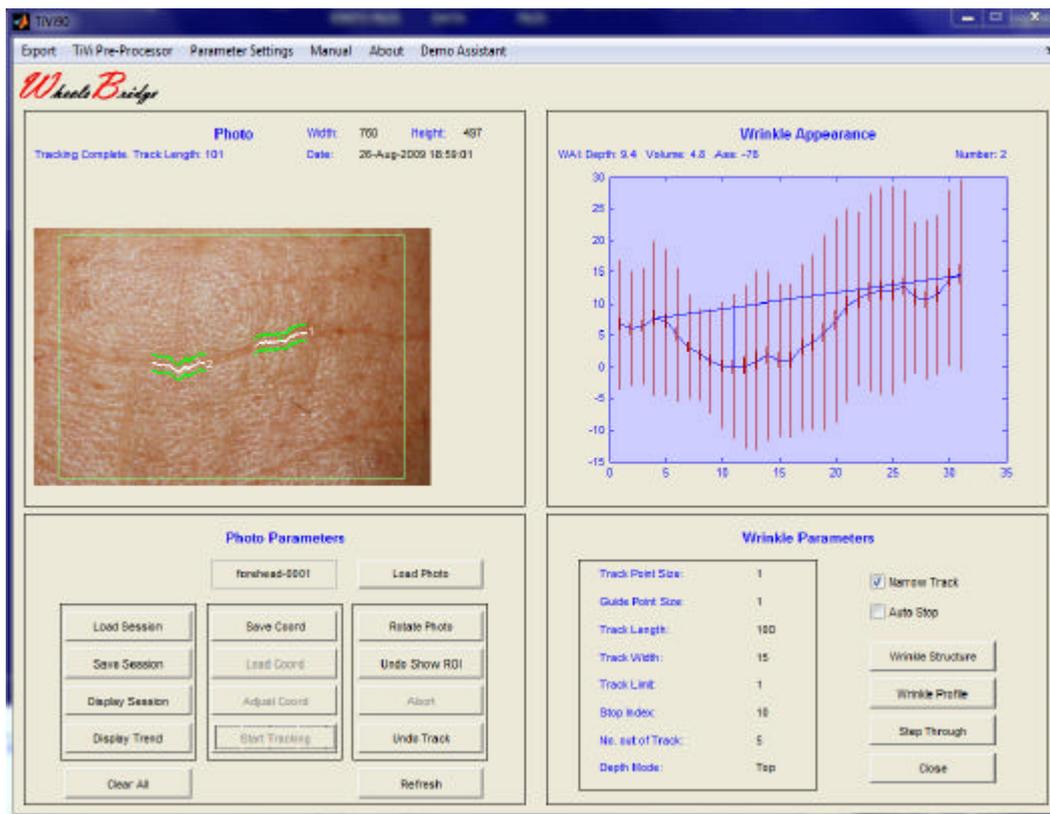
The name of the photo is displayed in the **Load Photo** edit box, while the **Height** and **Width** of the photo (in pixels) are displayed in the upper right corner of the **Photo** frame together with the **Date** at which the photo was captured. The next user action “Draw a Region of Interest” is displayed above the photo in the **Photo** frame.

1. **Edit box** – shows the name of the photo displayed.
2. **Load Photo** – to upload a photo from the hard drive.
3. **Wrinkle Map** – to open the *Wrinkle Map* window.

TiVi90 Wrinkle Analyzer

4. **Rotate Photo** – rotates the displayed photo 90 degrees counter-clockwise. To be used if the wrinkle to be analyzed runs vertically.
5. **Show ROI** – to display a region of interest if a **ROI** is drawn. When this button is clicked the action can be reversed by clicking it again (now labeled **Undo Show ROI**). In the **ROI** photo the green frame indicates the borders for placing the mouse to start a tracking procedure.
6. **Abort** – clicking this button aborts the current track action .
7. **Undo Track** – erases the latest wrinkle track.
8. **Refresh** – erases all tracks and **ROIs**.
9. **Load Session** – to load a saved session.
10. **Save Session** – to save a session.
11. **Display Session** – to display the results in a new window (the **Display Session** window). Several **Display Session** windows can be kept open simultaneously.
12. **Display Trend** – to open the **Trend** window in which the overall results are displayed.
13. **Clear All** – resets the TiVi90 system and prepares it for capturing or uploading a new photo.
14. **Save Coord** – to save the coordinates of the centre points of tracks and the associated ROI.
15. **Load Coord** - to load the coordinates of the centre points of tracks and the associated ROI.
16. **Adjust Coord** – to automatically make the final adjustment of green dots positions (indicating track centre points) provided they are positioned in the vicinity of the actual wrinkles.
17. **Start Tracking** – to automatically start tracking if the associated green dots are in position.

TiVi90 Wrinkle Analyzer



The **Wrinkle Appearance Index (WAI)**, (**Depth, Volume** and **Asymmetry**) is displayed in the **Wrinkle Appearance** frame together with the number of the wrinkle profile/structure displayed. The large vertical bars represent the standard deviation while the shorter and thicker bars represent to standard error of the mean.

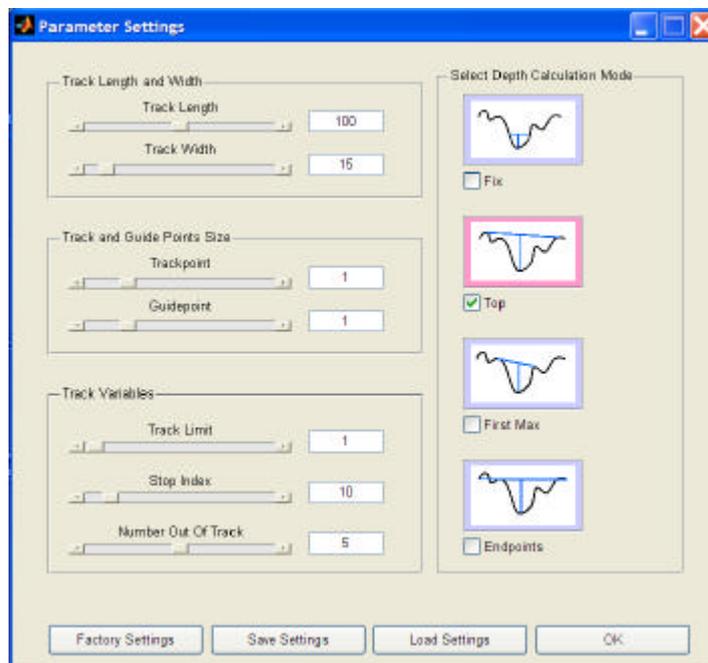
18. **Narrow Track** – to be checked if the track is to be continuous without any interruptions (recommended). With **Narrow Track** checked, the track-point is shifted no more than one pixel as the tracking proceeds from one vertical line to the next. This facilitates the generation of a smooth track.
19. **Auto Stop** – to be checked if the track is to be automatically stopped when the wrinkle becomes too fuzzy.
20. **Wrinkle Structure** – click this button to display a 3D profile of the wrinkle in the **Wrinkle Appearance** frame. Placing the mouse pointer on the structure changes the pointer to circular. The view angle can be altered by moving the mouse while keeping the left mouse button pressed.
21. **Wrinkle Profile** – click this button to display the average profile of a wrinkle in the **Wrinkle Appearance** frame.
22. **Step Through**– click this button successively to display either to **Wrinkle Structure** or the **Wrinkle Profile** of the actual tracks (up to ten tracks allowed).
23. **Close** – to close the **Wrinkle Analyzer TiVi90** window.

TiVi90 Wrinkle Analyzer

24. **Export** – to save the data associated with the tracked wrinkles in a MS Excel file (ASCII-format).
25. **Parameter Settings** – opens a new window in which the wrinkle tracker parameters can be set. The actual numerical values of these parameters are displayed in the separate **Wrinkle Parameters** frame.
26. **Drop Data** – to open the *Drop Data* window into which wrinkle parameters can be automatically exported.
27. **Manual** – online version of the **Wrinkle Analyzer TiVi90** manual.
28. **Language** – to set the actual language (available only in stand-alone mode).
29. **About** –to display the **Wrinkle Analyzer TiVi90 About** window.
30. **DemoAssistant** – to open the Demo Assistant for online assistance on how to use the Wrinkle Analyzer.

6.2 TiVi-90 Wrinkle Analyzer Parameter Settings window.

The **Settings Parameter** window is used for setting and saving the different track parameters.



1. **Factory Settings** – used for uploading the factory values (Default values) of the track parameters.
2. **Save Settings** – used for saving the actual track parameters. These values are automatically uploaded the next time the **Wrinkle Analyzer TiVi90** is opened.

TiVi90 Wrinkle Analyzer

3. **Load Settings** – used for uploading the saved track parameters.
4. **OK** – click this button to accept the new settings and close the **Parameter Settings** window.

The following tracking parameters can be set either by dragging the slider to the target value or by printing the target value in the edit box and clicking the keyboard **Enter** button.

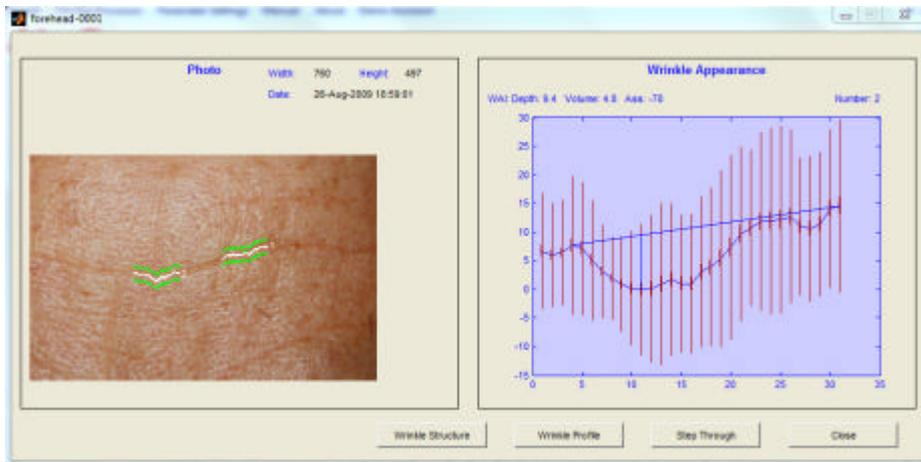
1. **Track Length** – determines the length of the track in horizontal pixels. During a tracking procedure the tracking starts at the mouse pointer (after clicking the left mouse button) and first tracks to the right (half track-length) and then tracks to the left (half track-length). The centre point of the track is marked by a green square.
2. **Track Width** – determines the number of vertical points around the latest track-point used to calculate the next track-point. This is done by calculating the minimum value along the **Track Width** and uses this minimum value as the next track point.
3. **Trackpoint Size** – sets the size of the track point (in pixels).
4. **Guidepoint Size** – sets the size of the **Track Width** points (in pixels).
5. **Track Limit** – the maximum number of pixels the track is allowed to jump in the vertical direction in between two successive track points. In operation only if the **Narrow Track** checkbox is un-checked.
6. **Stop Index** – this parameter determines how well defined the minimum value along **Track Width** has to be to be classified as a true track point and not a random minimum value only. In operation only if the **Auto Stop** checkbox is checked.
7. Technically the **Stop Index** is compared to the relative difference of the minimum value and the average value along the **Track Width**. A low value of **Stop Index** value is less tolerant to identifying a track point than a large value is.
8. **Number Out of Track** – sets the number of successive failures to identify a track point before the system determines that the wrinkle depth is too shallow to be dealt with. If the **Number Out of Track** is exceeded and the system tracks to the right, the actual tracking procedure stops and the system starts tracking to the left. If the system tracks to the left and the **Number Out of Track** is exceeded, the tracking procedure is completed and the profile, structure and **WAI** values are calculated based on the reduced **Track Length**.

6.3 TiVi-90 Wrinkle Analyzer Display window.

The **Wrinkle Analyzer Display Session** window is generated by clicking the **Display Session** button in the main window. The **Display** window displays the result of a specific

TiVi90 Wrinkle Analyzer

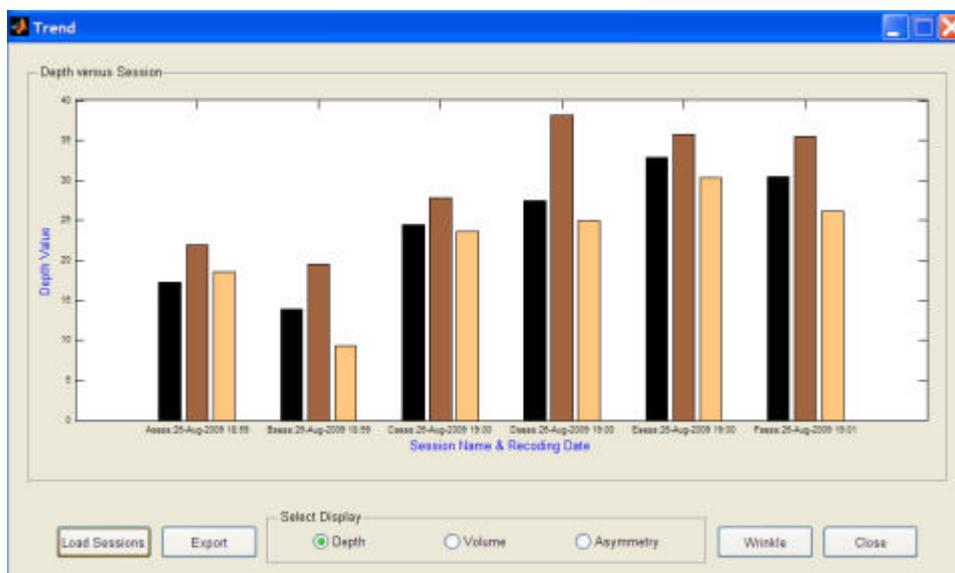
session. An infinite number of **Display Session** windows can be kept open and used as references.



1. **Wrinkle Structure** – to display the wrinkle structure in the **Wrinkle Appearance** frame.
2. **Wrinkle Profile** – to display the wrinkle profile in the **Wrinkle Appearance** frame.
3. **Step Through** – click to manually step through the wrinkle structures or profiles.
4. **Close** – to close the **Display Session** window.

6.4 TiVi-90 Wrinkle Analyzer Trend window.

The **Wrinkle Analyzer Trend** window is generated by clicking the **Display Trend** button in the main window. The **Trend** window displays the overall results in terms of **Depth**, **Volume** and **Asymmetry** of the wrinkles versus wrinkle number or session.



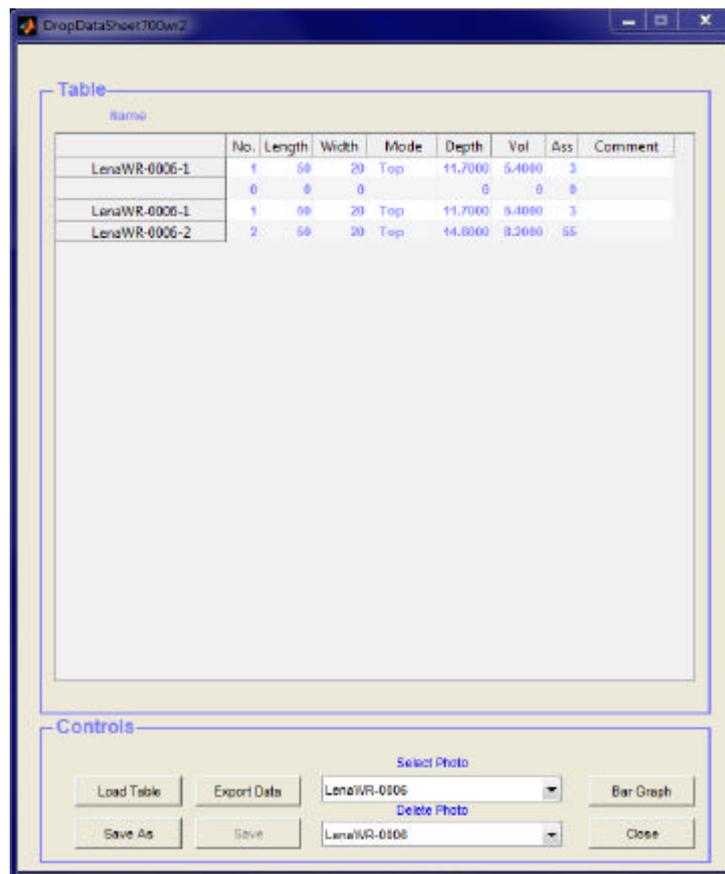
TiVi90 Wrinkle Analyzer

1. **Load session** – to upload one or more sessions simultaneously. To load more than one session press the **Ctrl** button and click on the sessions to be uploaded by the mouse pointer in the **Pick a File** window.
2. **Export** – to export the results to a MS Excel spread-sheet for further analysis.
3. **Wrinkle** – to select if the **Wrinkle Appearance Parameters** are to be displayed as a function of wrinkle number or date of recording the photo associated with the actual session. **Session** – to select if the **Wrinkle Appearance Parameters** are to be displayed as a function of session number.
4. **Depth** (in Select Display frame) – to display the depths of the wrinkles.
5. **Volume** (in Select Display frame) – to display the volumes of the wrinkles.
6. **Asymmetry** (in Select Display frame) – to display the asymmetry of the wrinkles.

6.5 DropData.

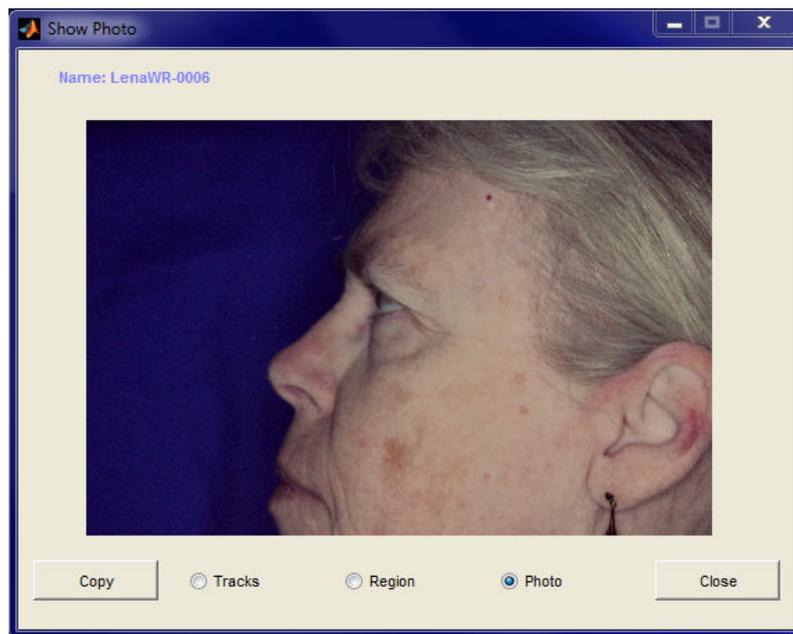
1. Open the **DropData** window by selecting **DropData** from the *TiVi Wrinkle Analyzer* pull-down menu.

TiVi90 Wrinkle Analyzer



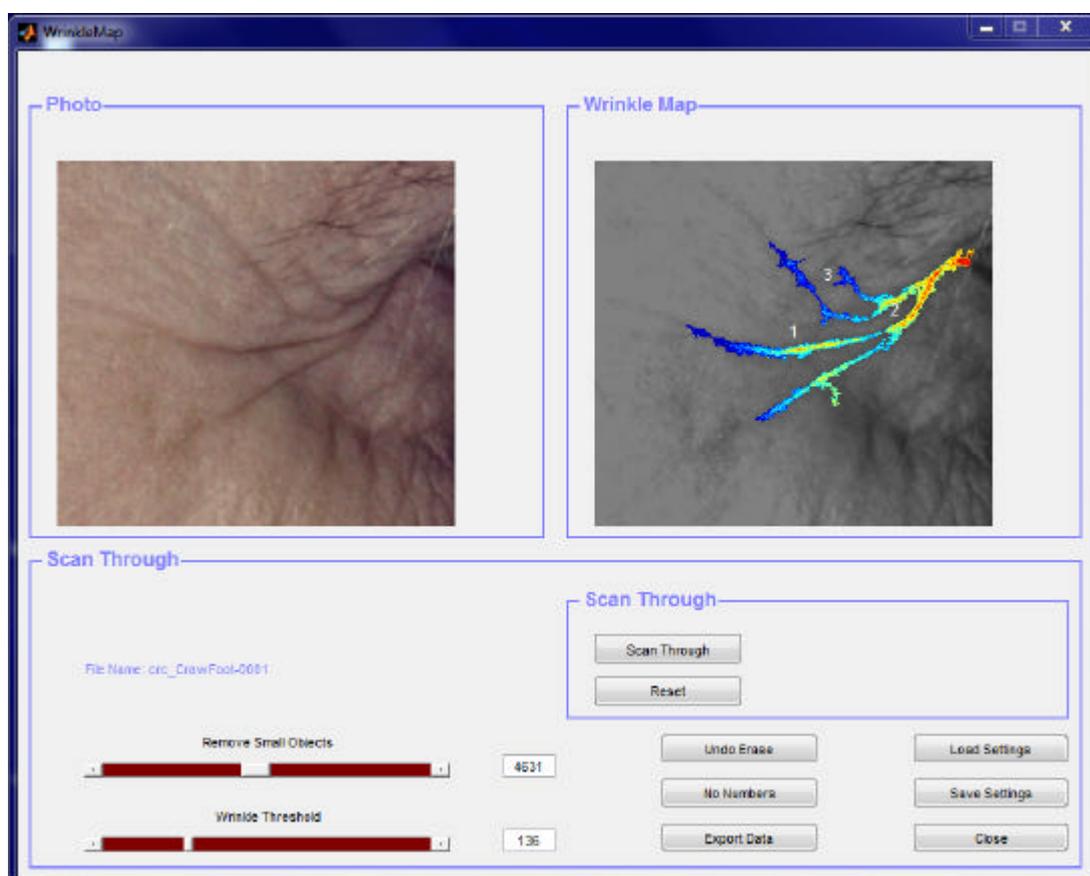
2. The table displays wrinkle data such as wrinkle number, track length, track width, track mode, wrinkle depth, wrinkle volume, wrinkle asymmetry and a column for inserting comments in the table.
3. The **Name** of the table (selected by the **Save As** function) is displayed above the table.
4. **Load Table** – to load an existing **DropData** table.
5. **Save As** – to save the actual table under a selected name.
6. **Save** – to save the actual table under its preselected name.
7. **Export Data** – to export table data to an **Excel** spread-sheet.
8. **Select Photo** menu – to select a photo to display in the **Show Photo** window.
9. **Delete Photo** – to delete a photo from the actual table.
10. **Bar Graph** – to display wrinkle data as a rotatable bar graph.
11. **Close** – to close the **DropData** awindow.
12. Open the **Show Photo** window by selecting a photo in the **Select Photo** menu.

TiVi90 Wrinkle Analyzer



13. **Copy** – to copy the photo to the windows clipboard from where it can be inserted into e.g. an Excel spread-sheet.
14. **Tracks** – to display the tracks in the actual photo.
15. **Region** – to display the region of interest.
16. **Photo** - to display the entire photo.
17. **Close** – to close the **Show Photo** window.

6.5 Wrinkle Map



1. **Photo** panel – displays the **ROI** of the actual photo.
2. **Wrinkle** panel – displays the corresponding *Wrinkle Map* with the wrinkle segments highlighted and the background skin displayed in grayscale colour.
3. **File Name** – displays the actual filename.
4. **Remove Small Objects** slider and edit box – to remove small objects from the wrinkle map.
5. **Wrinkle Threshold** slider and edit box – to change the threshold level for wrinkle detection.
6. Dragging the mouse pointer, after pointing on a wrinkle segment and pressing the left mouse button, to a position outside the Wrinkle Map – to remove the actual wrinkle segment from the wrinkles Map.
7. **Undo Erase** – to restore the original set of wrinkle segments.
8. **Enumerate / No Numbers** – to display or hide wrinkle segment numbers.

TiVi90 Wrinkle Analyzer

9. **Export Data** – to export wrinkle segment information to an **Excel** spread-sheet.
10. **Load Settings** – to load saved wrinkle parameters (**Remove Small Objects** and **Wrinkle Threshold**) and apply these to the actual *Wrinkle Map*.
11. **Save Settings** – to save the current **Remove Small Objects** and the **Wrinkle Threshold** parameters.
12. **Scan Through** – to display the wrinkle segments one by one together with information about wrinkle segment number, area and wrinkle score.
13. **Reset** – to reset the **Scan Through** procedure and display all wrinkle segments.
14. **Close** – to close the *Wrinkle Map* window.