Palatoglossatron 1.0

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1 Introduction

Palatoglossatron is a Windows application environment for doing ultrasound data processing. It implements the Palatron and Glossatron algorithms. It is designed to be efficient and flexible; it should also become easy to use with practice.

Feedback is strongly encouraged; there is total control over the environment, so new features are generally very easy to implement.

2 The project

Palatoglossatron performs operations within the context of a *project*. A project corresponds to one data collection session. An experiment with

30 subjects will have 30 projects. This organization makes sense because most settings for Palatron are specific to a single recording session.

The data for a project consist of images of the tongue in action (hereafter *tongue images*), and images of the palate (*palate images)*. The program keeps track of these as lists. There will typically be many more tongue images than palate images.

Palate Files	Tongue Files
palate1_+00e.jpg	example1_+00e.jpg
palate1_+00o.jpg	example1_+00o.jpg
palate2_+00e.jpg	example2_+00e.jpg
palate2_+00o.jpg	example2_+00o.jpg
palate3_+00e.jpg	example3_+00e.jpg
palate3_+00o.jpg	example3_+00o.jpg
. . .	exemplar1_+00e.jpg
	exemplar1_+00o.jpg
	exemplar2_+00e.jpg
	exemplar2_+00o.jpg
	exemplar3_+00e.jpg
	exemplar3_+00o.jpg
	. . .

3   Getting Started

To familiarize yourself with Palatoglossatron, copy the files from the Palatoglossatron directory of the shared drive to your own computer. The crucial Palatoglossatron files are Glossatron.exe and all of the .bin files in that directory. These are the only ones you need to make the program run.

Run Palatoglossatron. Do *File| Open* and select the 'nasal1.prj' project file.

3.1   Display Tidbits

In the status bar at the bottom of the screen Palatoglossatron indicates that you are looking at the image 'Bic1_00e.jpg.' This image is "finished" — the tongue surface has been traced and the dots have been tracked. We'll poke around a bit with this completed image to look at different parts of the program's display.

To the right of the filename on the status bar is a pair of numbers separated by a comma; these are the image coordinates of the cursor. As you move the cursor to the upper left corner, these numbers will approach zero; as you move the cursor to the lower right corner the numbers will approach 720 and 480.

To the right of the cursor coordinates are three numbers that describe the color of the pixel the cursor is over. The three numbers are red, green, and blue (RGB) values.

There are also a number of ways you can change the display of the trace. On the Main Toolbar, to the right of the Save button, are a triplet of yellow and red buttons. The button with the dot toggles the display of the dots on the trace. Click on it a few times to see the dots appear and disappear. The button with just a line toggles the display of the tracing line. Note that these buttons can be used in different combinations. Yet one button further to the right is a button with a radial grid on it. Click this button to toggle the display of the measurement grid that Palatoglossatron uses.

Finally, note that the *'Color'* menu has a number of different color options you can change, if you don't care for the defaults.

3.2 Moving around

Now let's look at some different pictures in the tongue image list. The Navigation Toolbar has five pairs of buttons, each providing a different navigational convenience.

The most straightforward navigation is simply moving forward and back. The buttons with the plain *'P'* (=Previous Image) and *'N'* (=Next Image) do this. Click *'N'* to move one image forward (which will be 'Bic2_00e.jpg'); then click *'P'* to move back to the first image. 'Bic1_00e.jpg' is the first image of the list; clicking *'P'* again will move you to the last image of the list; likewise clicking *'N'* while at the last image of the list will move you to the first image of the list.

The next pair of buttons aren't relevant for this particular project file; their functions are described below in the Command Reference section.

The middle pair, a *'P'* and *'N'* with yellow tongue traces in the background, will move to the next or previous *traced* image.

The next pair to the right, a *'P'* and *'N'* with the slashed red circle in the

background, move to the next or previous *untraced* image. Clicking on the *'Next untraced'* will take you to 'babe1_00e.jpg,' the next untraced image in the list, for example.

The rightmost pair of buttons make it easier to move around the list quickly. The button on the left, *'Short jump'*, shows you a list of up to 50 near-by images. Double-click on one of these images (or select it and click *'OK'*) to jump to that image. The button on the right, *'Long jump'*, is the same, but the list will include all the images in the project. The only reason to have a *'Short jump'* command in addition to the *'Long Jump'* command is that projects can have thousands of files, and that can make *'Long jump'* quite slow.

3.3   Tracing tongues

Navigate to 'babe1_00e.jpg' so that we can practice tracing a tongue image. This can be done manually. Move your cursor over the tongue surface, and hold the left mouse button down while dragging (i.e. as if you were drawing in PhotoShop). What you're trying to do is intersect the radii of the radial grid. When you hit one, Palatoglossatron will make a point. When you make two points on adjacent radii, Palatoglossatron will connect them with a line. To remove the measurement from a radius, right-click and draw across the radius. The point will disappear.[1]

To try automatic tracing, click the icon with the single *'G'*. The program estimates the position of the tongue; in this case it's a particularly bad estimate. Cleaning up the image is the same as tracing it for the first time. Use the left and right mouse buttons to make the trace better.

Why was Glossatron so bad? It was looking in the wrong places. Still on the Glossatron toolbar, click the icon with the dark grey kidney bean.[2] Two lines appear showing you where Palatoglossatron is looking for the tongue. This default guess is appropriate for most subjects, but this subject is unusually small. To change the search area, click the button to the right of the kidney bean (the kidney bean with the cursor). Now click and drag along the image; Palatoglossatron will change the search boundary closest to where your cursor is. Make the lower left boundary much

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[1]How easy it is to make a tracing depends on your input device. Some mouses work better than other; I have the best experience using a tablet and stylus to do it.

[2]For the record, it's supposed to represent Glossatron's search area.

lower, and also bring down the upper boundary on the left side. Now click the kidney-bean-and-cursor again. When you click the Glossatron button again, it will make a better (but still not perfect) guess.

There are a variety of options associated with automatic tracking, which are described in the Command Reference section below.

3.4   Palatron

Now look at the Palatron toolbar, and click the *'Palatron'* button, which has an angle/protractor sort of icon. Palatoglossatron transforms the tongue tracing of the current and displays the palate as well. Click the *'Trace tongue images'* button on the Glossatron Toolbar to go back to tracing the image. This is the final project. Now we'll find out how to get there.

Save your current project, and open 'nasal1paldemo.prj.' In this project the tongues have been traced, but we'll need to work on the Palatron settings.

To trace a palate, click on the leftmost button of the Palatron Toolbar. A palate image appears, without a trace; trace as much of the palate as you can see. Now look at the other palates; they've been traced already.

Before running Palatron, we need to define the Palatron boxes, which determine where Palatoglossatron will look for the dots. Click the *'Define Palatron boxes'* button. You are asked if you want to see a composite; click *'No'* for now. The image becomes black and white. The white represents everything Palatron things looks like a dot. You want to draw the boxes so that they encompass these dots. You'll perform a series of eight clicks; the status bar tells you what to do. When you're done, the image switches back to normal, and you'll notice yellow dots that represents Palatoglossatron's guess about where the dots are. It's right on.

But those boxes should be appropriate for all the image of the project, to make best use of the automatic tracking. To see how this can be easier, click the *'Define Palatron boxes'* button, and this time say *'Yes'* to the composite. Click *'OK'* on the box that comes up. After a processing delay, a black-and-white image appears similar to the first, but "smeared." You're looking at a composite of all the dots in the project. Now define the boxes as before, but this time with the assurance that your boxes will be appropriate for all of the images.

To make a final palate tracing out of all our individual palates, click the

'Make final palate' button. Palatoglossatron will run Palatron on all of the images, and draw them all in white. Using these as a guide, draw your final palate (which will appear in red).

Now we're ready to run Palatron on all the images. Rather than doing this one at a time, use the *'Batch Palatron'* command to run Palatron on all of the images simultaneously. After that you're shown all the transformed images; you can navigate through them.

There are a variety of options associated with Palatron, which are described in the Command Reference section below.

3.5   Other

Other tasks of Palatoglossatron, including making a project from scratch and other features not covered in the Getting Started section, are covered in the Command Reference section below.

4   Command Reference

4.1   Project-level commands

4.1.1   New (=Project Options...)

Click the new icon to start a new project. A dialog box appears with several prompts. The *'Project Filename'* field specifies where the project information will be stored (which will be a file with a .prj extension). This can be in the same directory as you ultrasound files, or in some common directory for an experiment. Image filenames are not recorded relative to the location of the project file, so the .prj file can be moved around freely.

You are prompted for palate files. Click *'Add files...'* to select multiple files to add to the project. Files will be added to the list box on the left. To remove files, select them from the list box and click *'Remove'*. If the filenames are listed in the box in an inconvenient order, click *'Sort filenames...'* to sort them alphabetically.

'Change directory...' is more relevant once the project has been in use for a while. As mentioned, Palatoglossatron stores absolute filenames. If you move your image files without telling Palatoglossatron, it will not work

properly. Therefore, to move a directory, first open your project with Palatoglossatron. Next, move your files to the new location in the directory structure. Then click *'Change directory...'*, answer in the affirmative, and move to the new directory that contains the files. Palatoglossatron will change all of the filenames accordingly, although there will not be difference in the listing of the files.

The commands for adding tongue images to the project are nearly identical. The only addition is the command *'Add directory...'*, which is useful when there are many tongue images. Simply move to the appropriate directory, and Palatoglossatron will add all of the .jpg files in that directory to your project. If you are unhappy with the order of filenames, you are S.O.L. The *'Sort filenames...'* command will only resort them in the same order.[3]

The request for a delimiter is relevant only to a certain navigational feature, to be discussed below. If the project files are sequences of images, then most likely they are all of a form like *test_0.jpg*, *test_1.jpg*, *test_2.jpg*, etc. The delimiter in this case is '_' — the substring that separates the token name from the sequence number.

4.1.2 Open

The *'Open'* command is the standard one. It loads a saved project into Palatoglossatron.

4.1.3 Save

The *'Save'* command is the standard one. It saves the current project.

4.1.4 Palatron options...

This command launches a dialog box where you can specify the options for the Palatron algorithm. These should be familiar.

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[3]This is to say that one would have to change the filenames themselves to achieve a different sort order.

4.1.5 Project options...

The *'Project options...'* command is a recapitulation of the dialog box used to initiate a project; it has identical functionality.

4.1.6 Project summary...

This launches a dialog box with a summary of the work done in the project. No changes can be made to the project from this dialog box; it is only meant to help you monitor your project, or to easily examine the results of Palatron. Use the check boxes to indicate what you want to see.

4.1.7 The "Colors" menu

The commands of this menu launch color selection dialog boxes. You can change the colors of the tongue tracing, the palate tracing, the radial grid, and the tracing dots.

4.2 Tongue tracing commands

4.2.1 Tracing the image

To trace the tongue image, left-click and drag on the surface of the tongue. A new point will be created wherever your mouse hits a point on the radial grid. If your mouse hits the same radius at a different point, the measurement point will be moved automatically. When two radii have measurement points, a line is drawn connecting them. To remove a point, hold down the middle mouse button (or depress the tracking wheel) while dragging the mouse across a radius.

4.2.2 Show grid

Click this button to display the radial grid over the image. Click it again not to display it (which is the default). Remember that you can change the color of the grid under the *'Colors'* menu.

4.2.3 Show dots

Click this button to not display the dots of tracing. Click it again to display them (which is the default). Remember that you can change the color of the grid under the *'Colors'* menu.

4.2.4 Trace tongue images

This button switches Palatoglossatron to tongue image-tracing mode, which is the mode you want to be in to trace tongue images. This is the default mode.

4.2.5 Glossatron this image

This command runs Glossatron, the automatic tongue surface extractor, on the current image. Note that it will overwrite any existing trace.

4.2.6 Glossatron-as-I-go

This option runs Glossatron every time you advance to a new image. If you are going to trace the tongue on every tongue image in your project, this is a good thing. It saves a click per image.

4.2.7 Batch Glossatron

This runs Glossatron on all the tongue images in the project. This also is a useful command when you are going to trace all the tongue images in the project. If you need a break, use this command. If you need to look busy, use *'Glosstron-as-I-go'*.

4.2.8 Clear trace

This clears the trace from the current image.

4.2.9 Remove orphans

This removes any measurement point that does not have a measurement on the radius to the left or to the right (i.e. those that are not connected

by a line to any other). These occur quite commonly because of accidental clicks.

4.2.10   Batch remove orphans

This performs the above command on all the tongue images in the project.

4.3   Palate tracing commands

4.3.1   Trace palates

This switches Palatoglossatron into palate-tracing mode, where you trace palate images. It works just the same as ultrasound-tracing mode, except that the images are palates.

4.3.2   Make final palate

The purpose of this command is to form a final palate tracing from the multiple palate images. Several things need to be in place before you run this command:

- At least one traced palate image.

- The Palatron boxes must be selected.

- Appropriate Palatron settings must be defined.

The first two conditions are logical necessities, and Palatoglossatron will warn you if you have forgotten something. The third is a matter for trial and error. The discussion of some other below will illuminate the process.

When the above conditions have been met, Palatoglossatron will run Palatron on all of your palate traces, and display them all simultaneously. It will expect you to then trace the final palate image, which you should do in consideration of all the images. Once this is done, you're free to move back to ultrasound tracing mode, or perhaps to palate tracing mode to adjust some palate images.

The palate you trace must be within the radial grid. To see the grid and whether your palate falls short, click the '*Show grid*' button. You may need to adjust the '*Palatron options...*' to get an appropriate position. The display will automatically refresh when you change the Palatron options.

4.4 Palatron commands

4.4.1 Palatron this image

Runs Palatron on the current image. As discussed above, there must be a trace present, and the Palatron boxes must be defined. This command also shifts you into a mode of viewing the transformed image. If all goes well, you should see a palate and a tongue. If you don't see one or either, it may be because you haven't traced them yet (i.e. traced a final palate or traced the tongue). It may also be that your Palatron settings are so bad that the display is off the screen.

4.4.2 Batch Palatron

This runs Palatron on all the tongue images in the project.

4.4.3 Define Palatron boxes

Use this command to define the Palatron boxes. Two points on a plane can define a box. As prompted in the status bar, you will click the upper left corner and then the lower left corner for the search boxes, in the following order: upper left, upper right, lower left, lower right. Boxes will be drawn as you click. After clicking the last box you will be sent back to ultrasound tracing mode.

But before that happens, very likely you will get the question "Include images without traces?" This is Palatron executing the *'Composite Palatron view'* command, which is discussed below in detail.

4.4.4 Show boxes on image

The command draws the boxes you defined on the current image. It makes it easy to see if the dot drifts out of the box.

4.4.5 Show dot positions

Leave this button depressed to see where Palatron estimates the dots to be. It will draw dots, as it calculates them, in the trace color. If Palatoglossatron's dots are not on the real dots, there is a problem.

4.4.6   Manually specify dots for this image

Click this, and then click on each of the tracking dots in the familiar order (upper left, upper right, lower left, lower right). Automatic tracking will never work 100%, so this is a back-up. When you have clicked the last dot, it shows you the positions you have chosen.

4.4.7   Clear my dot specification

Use this command if you have changed your mind and want Palatron to track the dots automatically after all. If you just want to change the dot positions, re-run *'Manually specify dots for this image'*.

4.4.8   Palatron view

This gives you a Palatron's eye view of the current image, based on your current Palatron settings. Pixels that are above threshold (where threshold can be defined variously in the *'Palatron options...'* dialog box) are shown in white; other pixels are shown in black. White pixels that are not part of the dots that nevertheless fall in the boxes are problematic, since they will affect dot-tracking.

   Use this command on a single image to adjust the Palatron settings. The Palatron view will be automatically updated when you change the Palatron settings.

4.4.9   Composite Palatron view

Run this command to get an overview of where the dots are throughout the project. Formally it is an OR over the Palatron views for all the images you want. The display is a smear of all that Palatron sees (as before, according to the current Palatron settings). When you click the button, Palatoglossatron asks, "Include images without traces?" Click *'Yes'* to consider all images, or *'No'* to consider just those images where you have specified a trace.

   The composite view is created when you define the Palatron boxes. This allows you to ensure that only dot pixels are included in the boxes.

   If you change the Palatron options in composite view, the view will be refreshed. Since this can take a while, it may be preferable to switch to plain *'Palatron view'* before changing the options.

The assumption is that you don't want to wait for the composite every time you view the composite. Therefore this command will display a stored composite image if it is available.

4.4.10   Refresh Palatron composite

If you do not want the stored composite image, click *'Refresh Palatron composite'*. This will refresh the composite. You might want to refresh the composite if you have traced more files, or if you have changed the Palatron settings while not in composite view mode.

4.4.11   Show transformed trace

This button causes all images to be displayed in their transformed state. If an image has not been traced, or has not been Palatroned, this will result in an uninteresting picture.

4.4.12   Show palate

This toggles the palate display, of course applicable only when you are viewing the transformed tongue image.

4.5   Navigation Commands

4.5.1   Previous image

This command displays the previous image in the list (whether and ultrasound or palate image). If you are at the first image, it produces the last image.

4.5.2   Next image

This command displays the next image in the list (whether and ultrasound or palate image). If you are at the last image, it produces the first image.

4.5.3   Previous series

Displays the first image from the previous series (where a series is defined as having the same prefix before the delimiter, e.g. "image1_0.jpg"

and "image2_0.jpg" are of different series, while "image1_0.jpg" and "image1_1.jpg" are of the same series.

4.5.4 Next series

Displays the first image from the next series.

4.5.5 Previous traced

This command displays the previous traced image in the list (whether and ultrasound or palate image). If you are at the first image, it produces the last traced image.

4.5.6 Next traced

This command displays the next traced image in the list (whether and ultrasound or palate image). If you are at the last image, it produces the first traced image.

4.5.7 Previous untraced

This command displays the previous untraced image in the list (whether and ultrasound or palate image). If you are at the first image, it produces the last untraced image.

4.5.8 Next untraced

This command displays the next untraced image in the list (whether and ultrasound or palate image). If you are at the last image, it produces the first untraced image.

4.5.9 Short jump

Produces a dialog box with the list of files, the fifty before the current image and the fifty after. Double click on any file to jump to that file. Or, select the file and click *'OK'*. The entire file list can be obtained with *'Long jump'*, but *'Short jump'* will load noticeably faster when there are many (say, more than 5000) images in the project.

4.5.10 Long jump

Produces a dialog box with the list of all the files in the project. Double click on any file to jump to that file. Or, select the file and click *'OK'*.

4.6 Overlay display

Palatoglossatron will create a display of all your tongue tracings. Click the *'Overlay display'* button, which launches a dialog box. Use the *'Browse'* button to select a display schema (discussed below). Use the slider to adjust the brightness of the traces (left means darker, right means brighter). Click *'OK'* to view the display. The *'Save display'* button will save your display as a JPEG image.

A display schema is a plain text file that tells Palatoglossatron what color to draw the traces. Each line represents a word. First is the word, and then, separated by tabs, are RGB values for that word's color. The example below shows this:

bod	255	0	0
bond	255	0	0
bock	0	0	255
bog	0	0	255
bomb	0	0	0
bomp	0	0	0

This file will display *bod* and *bond* in red, *bock* and *bog* in blue, and *bomb* and *bomp* in black (which is to say, they'll be invisible). Words that aren't in the schema file won't be displayed, either.