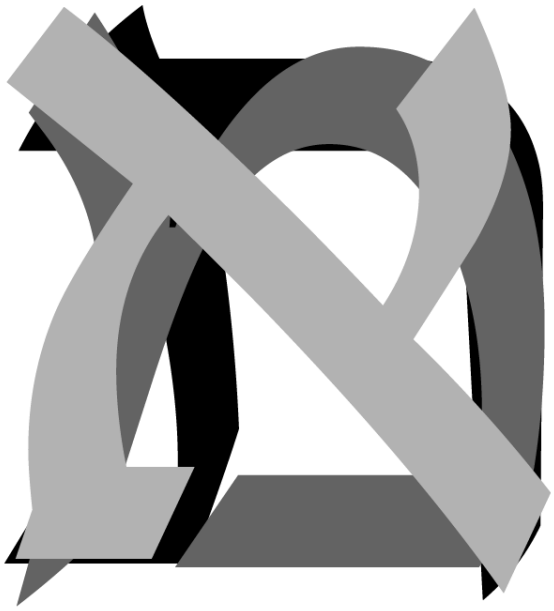
TruthMarker – User Manual



February 1, 2022

General Concept

TruthMarker was designed as a flexible image-annotation platform. The focus of this document is on the annotation, and digital capture, of Goldmann visual fields. This allows the quantification of the hill of vision, and reproduction of the field in 2D and 3D.

Several annotation types are supported, including points, polygons, splines, multi-choice, and text. Which annotations are available, and how to display those on the images is configured via an XML file. Given our focus on annotating visual fields, the examples in this User Manual focus on splines, points, and multiple choice to annotate isopters, fiducial points, and laterality respectively.

A configuration file (VF-Tracing.xml) is provided, which is a template for annotating Goldmann visual fields. This configuration file supports annotation of a set of isopters, a set of fiducial points, and the laterality (OS/OD) of the eye from which the field was obtained.

Fiducial points are required to provide spatial context for the isopters. For example, is a spline representing a I4e isopter spanning 30 degrees or 10 degrees? In our examples, we use points placed at specific landmark positions in polar coordinates (θ,r): (0,0), (0,90), (90,70), (180,90), and (270,70).

A second configuration file (configuration.xml) is also provided with the application. This configuration file provides examples of a broader set of fundamental annotation types: polygon, spline, point, multiple choice, and free text.

Basic Use

When you first launch TruthMarker, the main interface window is presented. Figure 1 presents an annotated version of the main interface, in which the primary features are highlighted in various colors. The project selection area in the left sidebar is highlighted in magenta and allows selection of the project to be worked on. After selection of a project, the thumbnails for the images associated with that project are loaded into the image selection area, which is highlighted in cyan. This is a scrollable overview of all images in a project, which allows selection of an image to annotate. The images are presented in order sorted by filename from left-to-right, and top-to-bottom. When an image is selected, you will be taken to the image annotation interface to annotate based upon the features specified in the selected configuration file. The file that defines which features should be annotated is selected using the drop-down selection item, annotated in blue. The final item in the main interface is the export button, which is highlighted in red. This triggers the generation of the project-wide annotation file for the complete set of images.

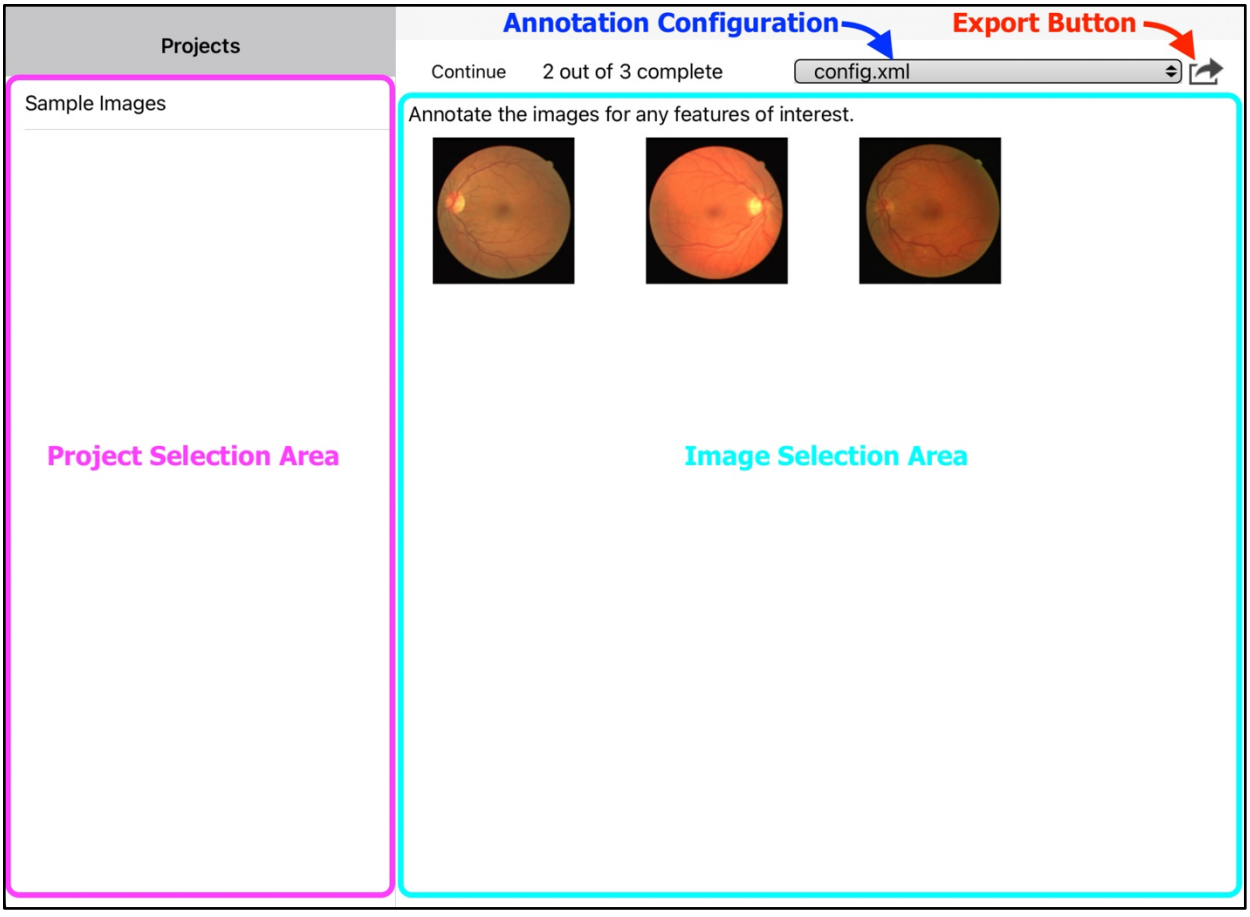


Figure 1. The main interface window, which allows selection of the project and image to annotate. Data export and selection of configuration file is also available in the main interface.

Loading Data

There are two types of data that may be loaded into TruthMarker. The first type of data is XML configuration files. The second is zip-compressed folders of images, in which the folder name is used as the project name within TruthMarker.

To load data onto your iPad, you must first connect your iPad to your Mac using the appropriate cable (e.g., USB-Lightning). If you are connecting your iPad to a computer for the first time, you may need to tell your iPad to trust that computer before it is available in your Finder window. As shown in Figure 2, loading the set of images (a project) into TruthMarker is as simple as dragging the zip file into the TruthMarker location within Finder. To navigate to the correct location, first select your iPad from the sidebar in Finder, as shown in red in Figure 2. Next, select the Files view within your iPad, as shown in orange in Figure 2. Finally, drag your ZIP-compressed folder of images into the TruthMarker application on your iPad as shown in yellow in Figure 2.

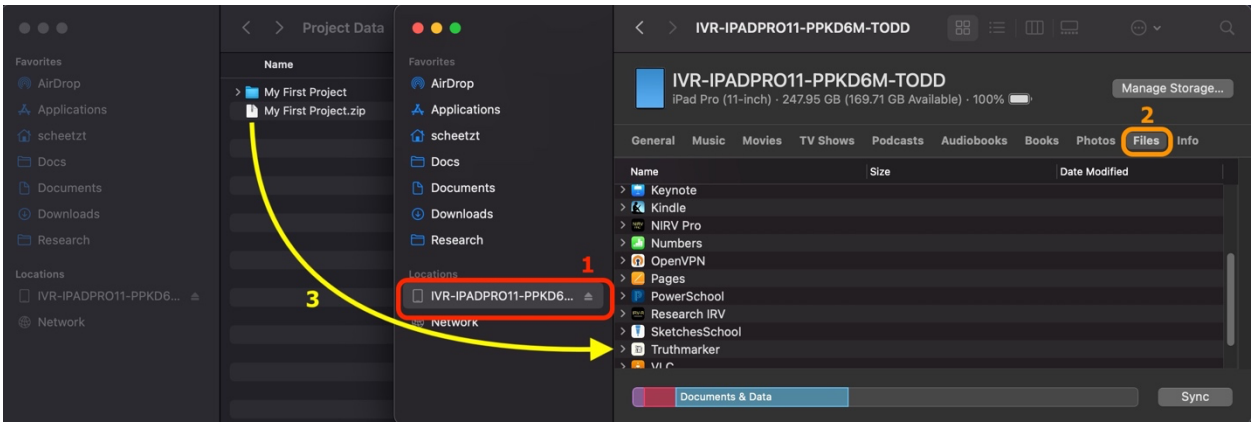


Figure 2. To load data onto your iPad, simply drop a zipped folder of images into the TruthMarker location on your iPad using Finder in MacOS.

After successfully loading the ZIP compressed file into the TruthMarker application, you will need to stop TruthMarker and restart the App. This will trigger the project loading mechanisms, which will unpack the Zip and generate the thumbnail images used in the image selection area.

Annotating Images

The Image Annotation interface is shown in Figure 3. The selected image is presented, along with an overlay presenting several buttons and the interface needed to begin annotating features. The overlay may be hidden by pressing the button labeled Hide, highlighted in red on the image below, or my tapping anywhere on the image. Tapping on the image when the overlay is not being displayed will toggle the overlay to be displayed. Navigating between images is accomplished in two ways. The user may either press the All Images button, shown in green in the figure below, or they may navigate by swiping across the screen. Pressing the All Images button will take you back to the main interface, allowing selection of specific images based upon their thumbnail, selecting a different configuration file, or selecting a different project. Swiping from right to left will advance the image; and swiping left to right will navigate backwards. Additionally, the name of the current file, shown highlighted in blue, is presented in the top-center portion of the overlay. At the bottom of the overlay the annotation bar is presented. This contains buttons for the features specified in the configuration file. In this case, we have 18 isopters (standard, scotoma, and open for each of I1e, I2e, I3e, I4e, III4e, and V4e isopters), plus 5 fiducial points, and a switch to set the laterality of the visual field.

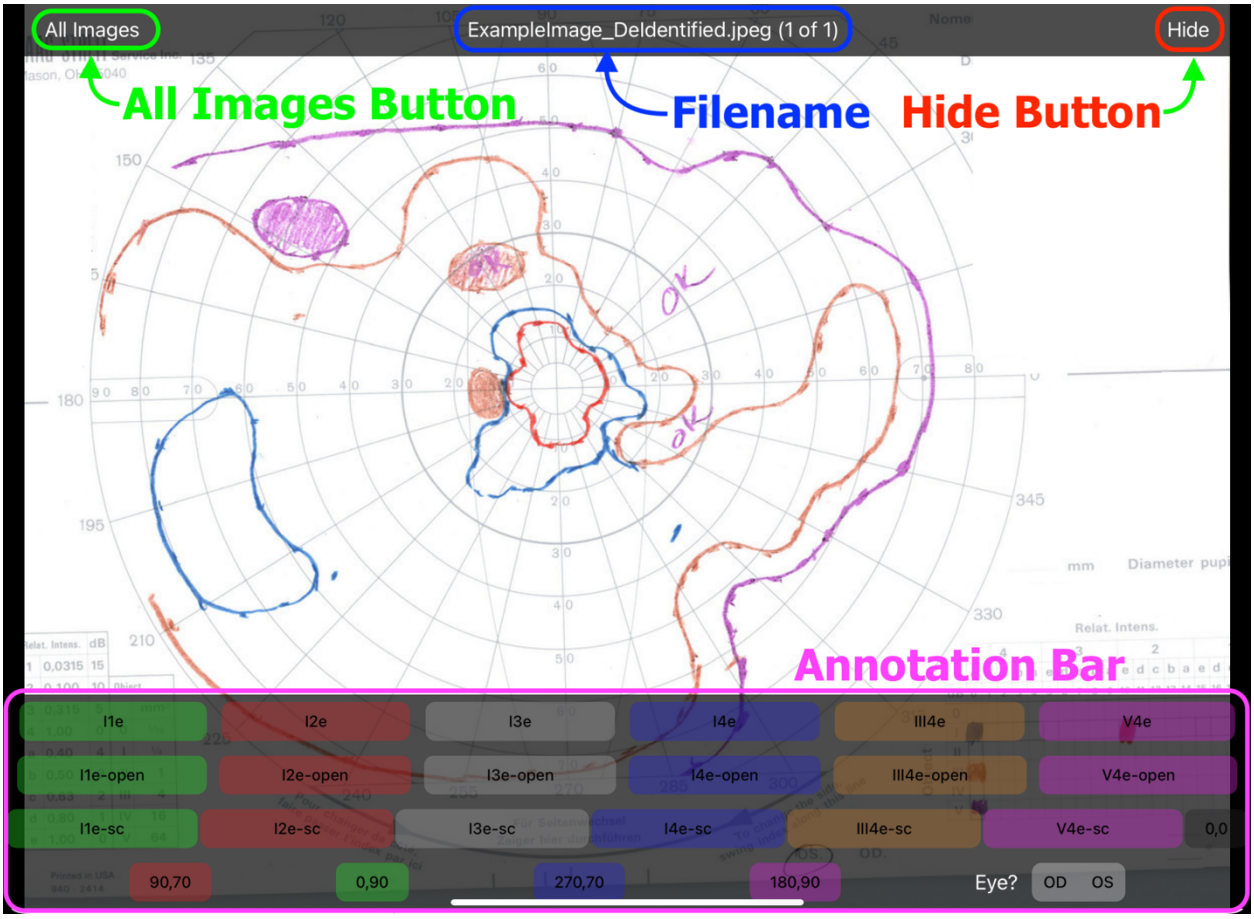


Figure 3. The Image Annotation Interface.

To begin annotating features, you first press the button corresponding to the feature you wish to annotate, and then tap the region of the image you with to annotate with that feature.

For example, Figure 4 shows a 0,0 fiducial point has been placed on the image. But that point is not at the 0,0 position of the visual field being annotated. To address this, we can tap on the point feature to edit the point. This will bring up the “squid” which allows us to move the point - and also to delete it. The squid is shown in Figure 5. To move points, you press on one of the movement pads and drag the point to where you would like it to be. The move points allow the central “cross-hair” of the squid, which represents the position of the feature, to be observed while moving the point.

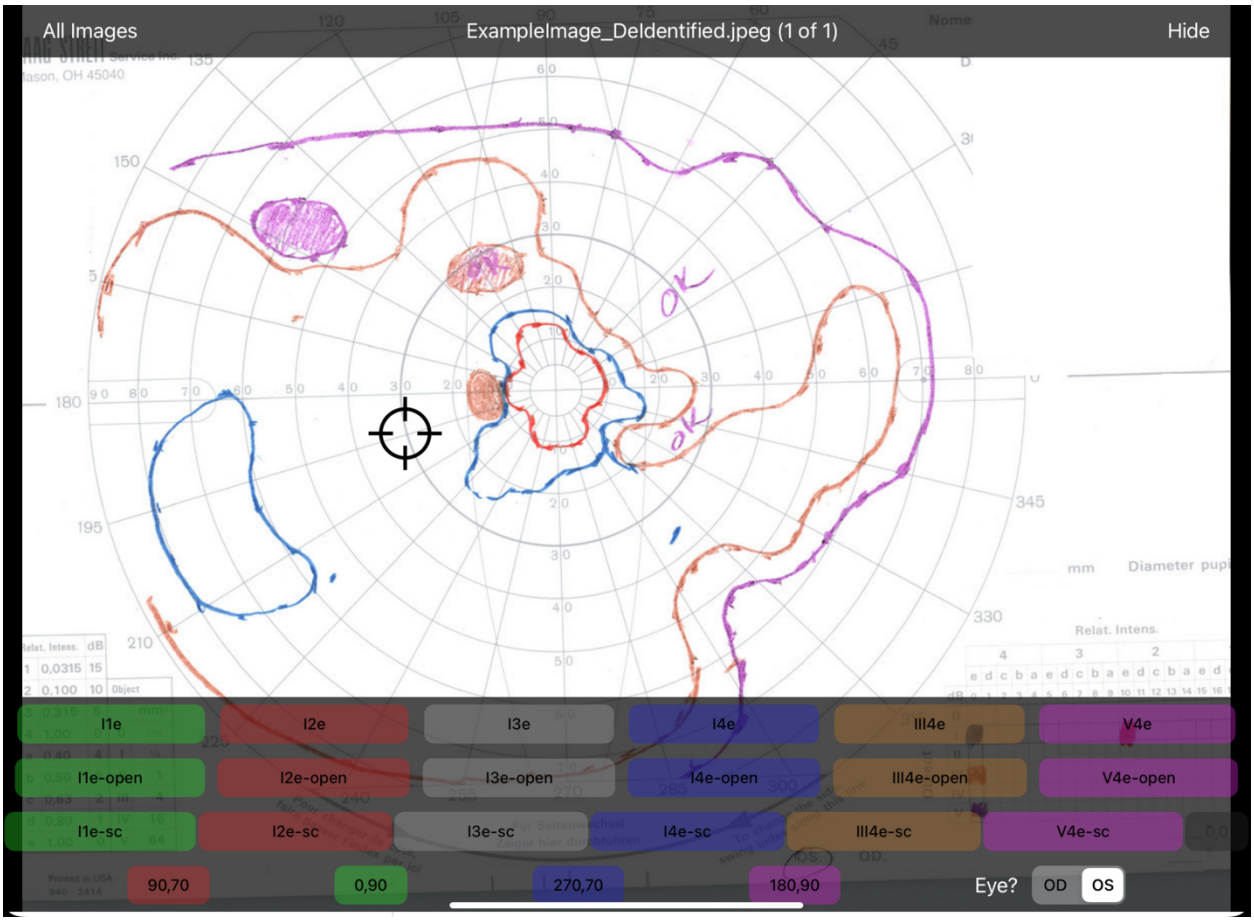


Figure 4. This figure shows a 0,0 fiducial point that has been misplaced.

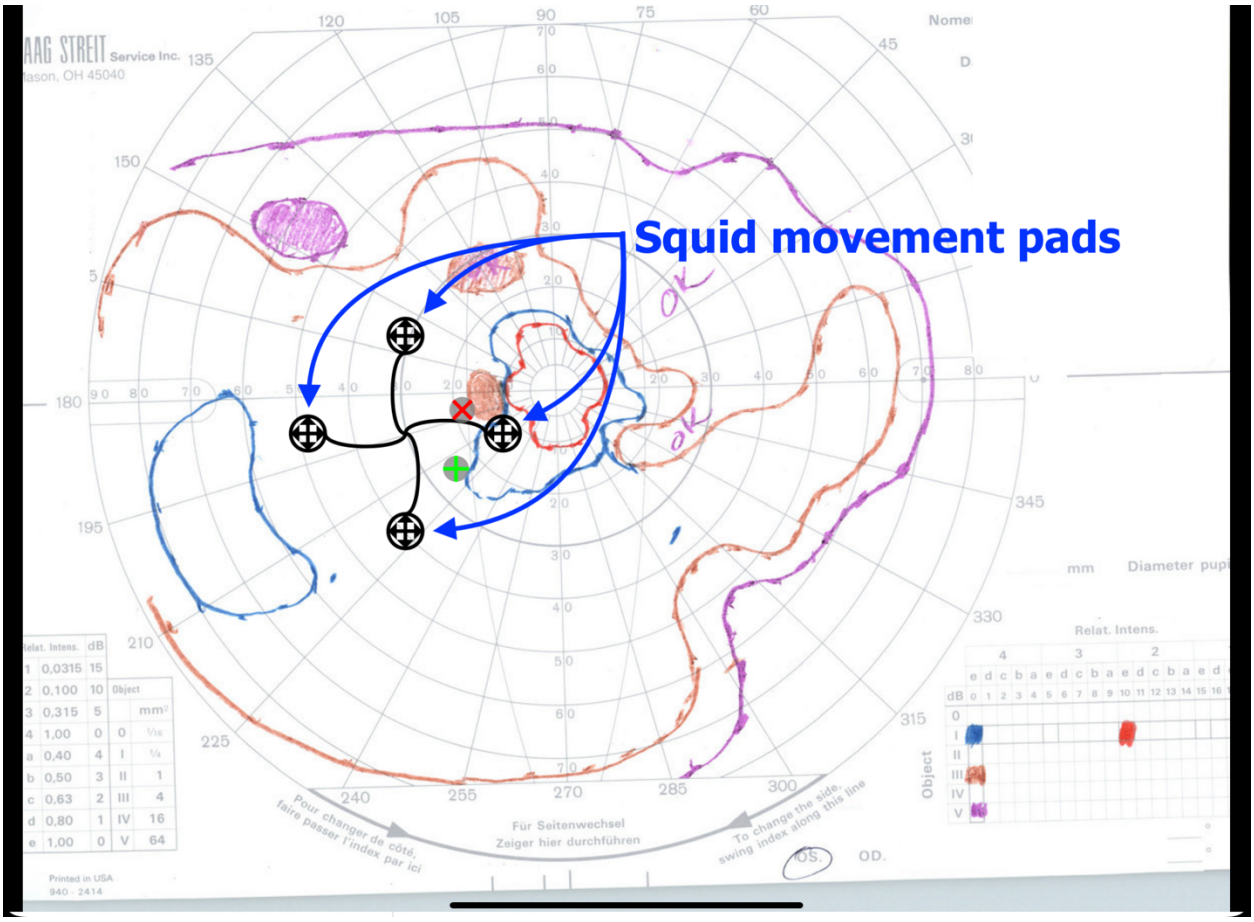


Figure 5. This figure shows the features of the squid element.

The isopters and scotomas are modeled as Splines. The exception are open isopters, i.e., isopters that are incompletely recorded. These are typically used when the perimetrist judges there to be sufficient information to "fill in the blanks" such as the case for the V4e isopter in Figure 5 above. For open isopters, a PolySpline is used. Both Splines and PolySplines are annotated by selecting a series of points corresponding to the general shape of the line to be annotated. As seen in the squid figure above, additional points can be added by selecting an existing point next to the position of the desired point and pressing the "+" button. Similarly, points can be removed using the "-" button. To delete a Spline, you must delete the points for that Spline. Once fewer than 3 points remain, the Spline will be removed entirely.

Each isopter is a "solid" entity, meaning that a selection within that shape will select that shape. This can lead to challenging behavior as an isopter inside another isopter (e.g., a I2e inside a I4e) may be impossible to select. Therefore, our recommended procedure is to work from the inside-out to avoid accidentally selecting the wrong feature. As each new feature is added, ensure that its points have been placed where you want them prior to moving to the next feature. For explicitly:

1. Place the 5 fiducial points, and fine-tune their positions
2. Starting from the innermost features

a. Quickly place the overall points for the feature
b. Fine-tune the set of points for that feature

Each isopter should be complete before moving on to the next isopter. This is important, as attempting to edit points later will be challenging. We can see the application of this strategy in Figure 6. Starting in the upper-left with the five cardinal fiducial points. The addition of the first isopter is shown in detail, with the other two sub-images in the top row of Figure 6 showing the contextual difference before and after the I2e isopter has been selected for annotation. The middle row of images shows an almost complete isopter on the left, in which the annotation is still rendered as a polygon. In the middle, that isopter has been closed and the annotated isopter is now show as a spline, with substantial variance from the clinically-acquired isopter. Finally, in the rightmost image in the middle row, we see the final isopter after the points of the spline have been fine-tuned.

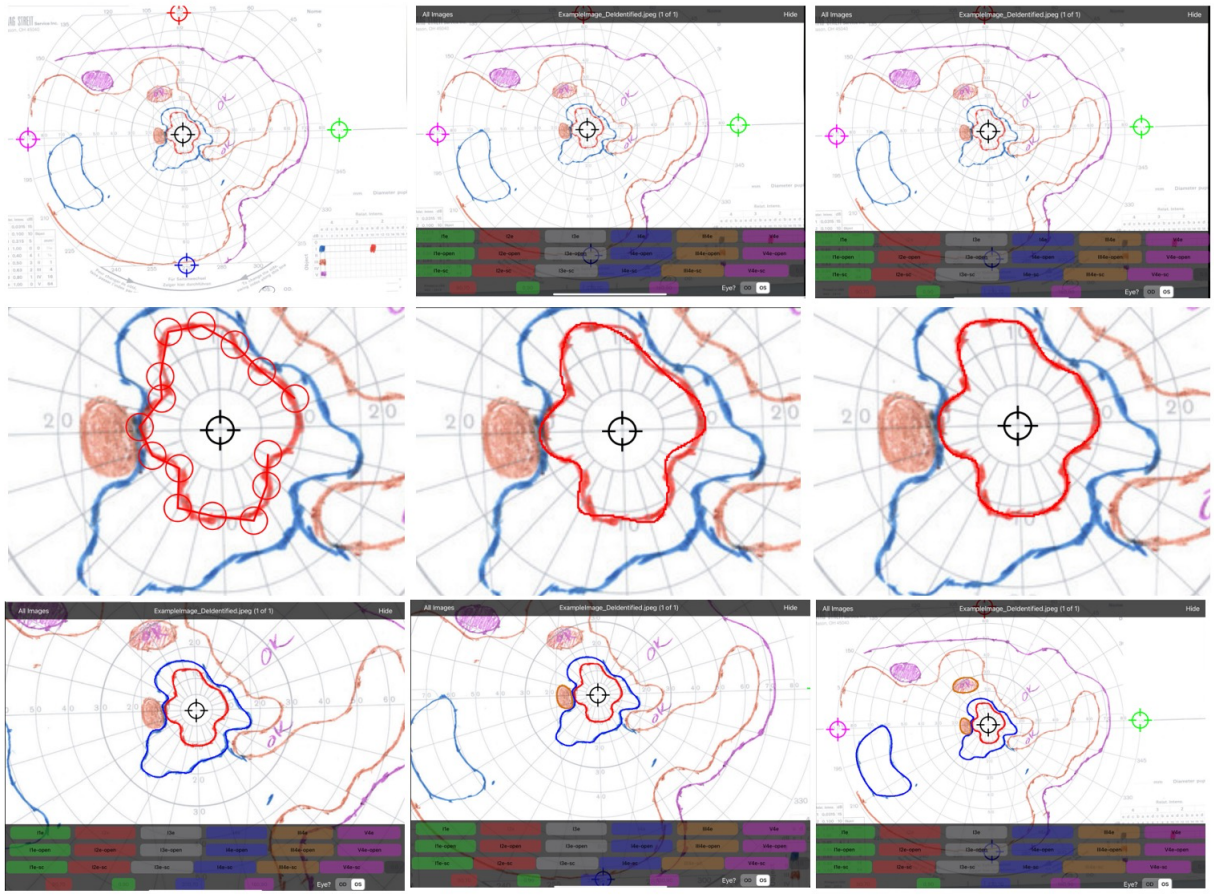


Figure 6. Example of the recommended annotation strategy. This figure highlights the steps.

As isopters are added to the image, the annotation bar at the bottom may occlude the accurate placement of the annotated points. In such cases, some points must be placed in an incorrect position, and then repositioned after hiding the annotation bar. Two examples of this are shown for our example image in Figure 7. The first row represents the annotation of the open III4e isopter. In this instance, the lower portion of the open isopter is partially occluded, but we are able to annotate the final point. Once the open isopter has been terminated (i.e., the final

point added, requiring a selecting the last point a second time) the annotation bar can be dismissed by touching the screen, and the points of the open III4e can be edited to match the clinical obtained isopter. The middle image shows the preliminary open III4e isopter after the annotation bar has been dismissed. The right image shows the open III4e after the points have been edited. The open V4e isopter is annotated similarly, but in this case the terminal point is occluded by the annotation bar and must be adjusted.

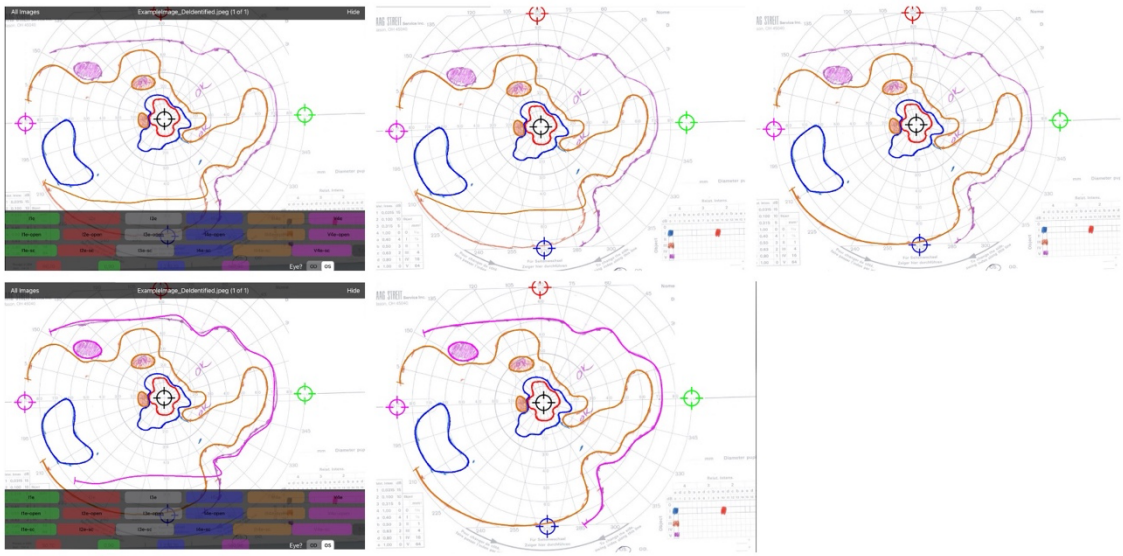


Figure 7. Annotating occluded isopters.

Retrieving Data

There are two primary strategies for retrieving the annotations from TruthMarker. The first is to send them via email. This can be done by pressing the Export button, shown in the main interface. This process concatenates the individual XML files into a single file, which is then attached to an email using the Mail app. This requires that the user has already set up at least one email account with the Mail app.

The second strategy to retrieving TruthMarker annotations is shown in Figure 8. In brief, you connect the iPad to an Apple computer and navigating to the TruthMarker application files. The user must still press the Export button before attempting to download, as that signals the App to build the concatenated annotation file. The downloading is done in a Finder window by selecting the iPad (highlighted in yellow), then select the Files view (highlighted in orange), and then open the TruthMarker folder using the "carrot" at the left of the TruthMarker name (red arrow).

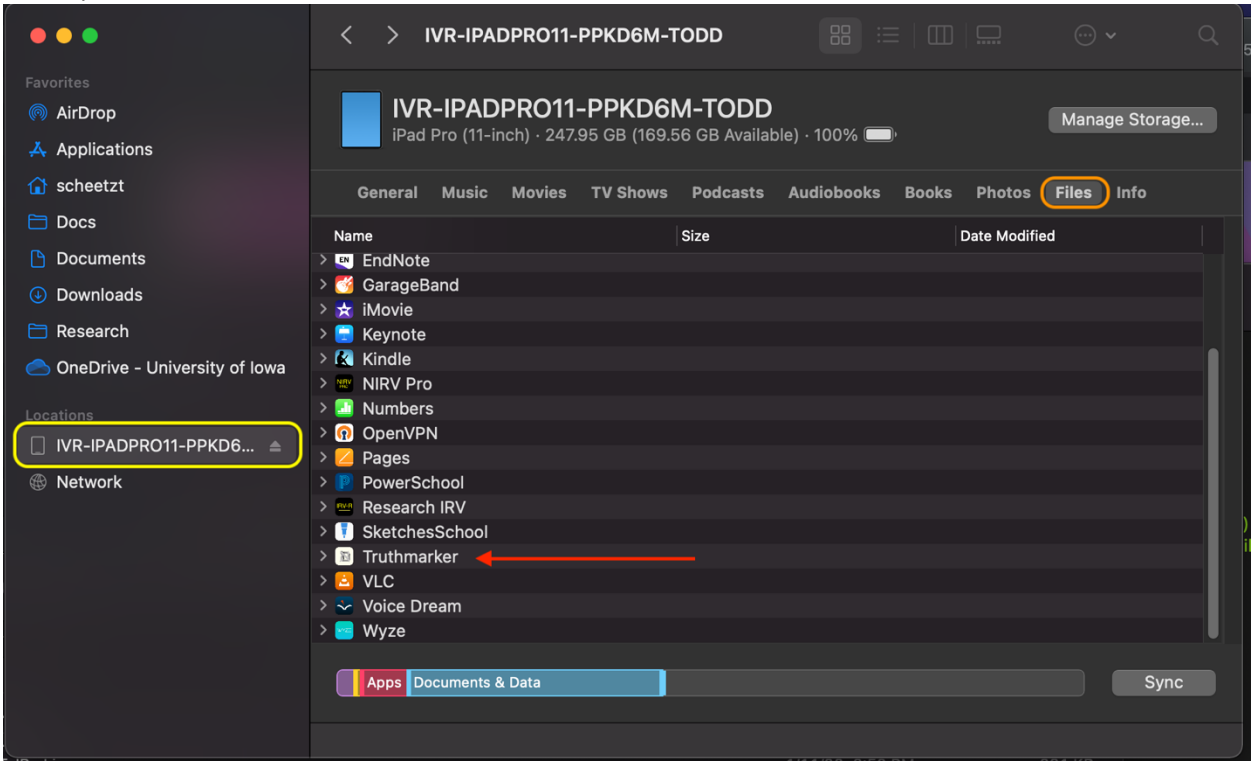


Figure 8. Navigating to the XML annotation files in Finder.

After opening the TruthMarker folder, you will see a set of folders and files. Each project should have 3 folders and may have one annotation file, such as "Sample Images-annotations.txt" shown in Figure 9. This folder also contains the XML files used to configure the annotations. To transfer the files to your local computer, just drag-and-drop the file from that Finder window.

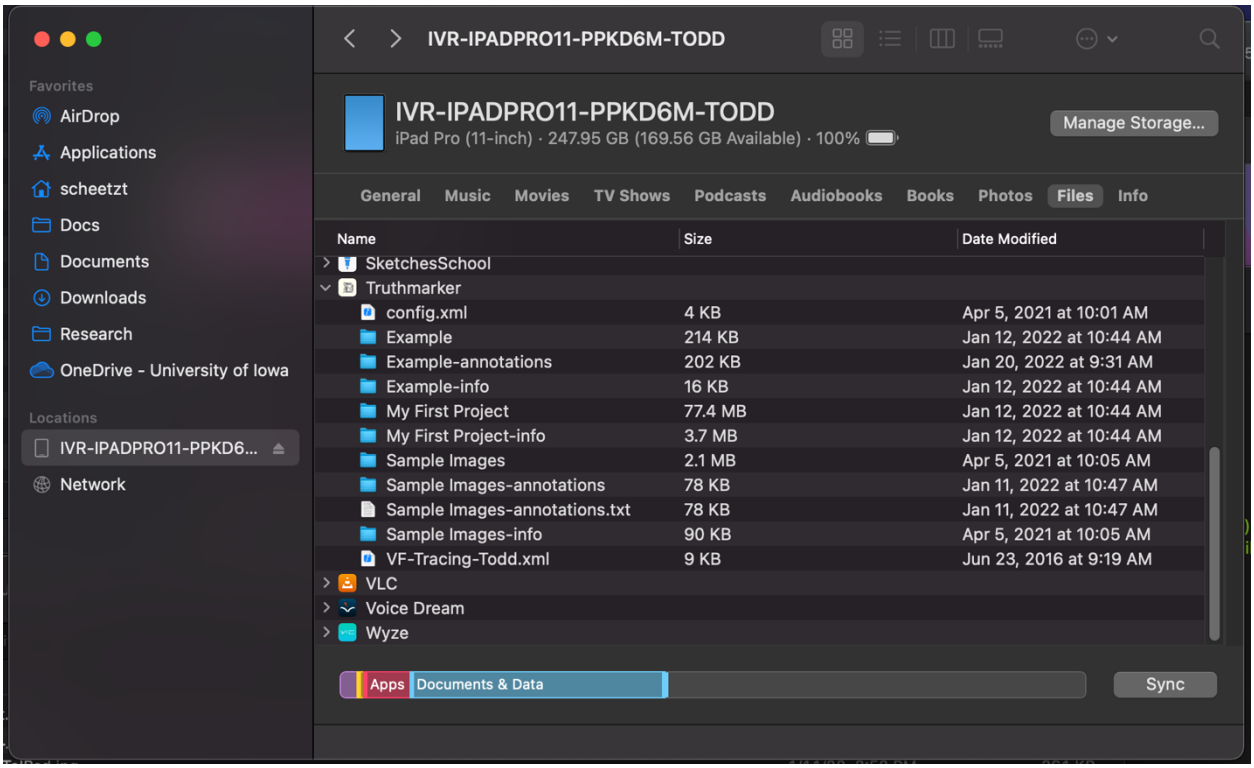


Figure 9. Files and folders in the TruthMarker applications folder.

Known Limitations

Very large images can cause the application to crash, particularly if you are rapidly swiping through a large set of images. This limitation is highly hardware dependent. In our hands on iPads, 1 megapixel images are very stable on all platforms. Higher resolutions may cause sporadic crashes, particularly on older iPads.

When loading a new project from a Zip file, the application must be re-started. This is currently required to initiate the unpacking of the Zip file.

Acknowledgements

The TruthMarker App was originally developed by Mark Christopher, as part of a Master of Science degree in Biomedical Engineering at The University of Iowa. Ongoing support of the program is provided by The Institute for Vision Research (https://ivr.uiowa.edu).