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**User's Guide**

# **Pixcavator IA 4.2**

**Image Analysis**

**Intelligent Perception Co.**

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## Overview

Pixcavator is an image analysis program for scientists and researchers. It captures contours of objects in the image and produces an Excel spreadsheet with the objects' locations and measurements.

The analysis takes three stages:

- Stage 1: automatic. A data structure – graph – is created that contains complete information about all possible objects in the image.
- Stage 2: semi-automatic. The user moves sliders corresponding to objects' characteristics to instantly change their contours and choose the best segmentation. The output data is updated in real time.
- Stage 3: manual. The user can exclude the remaining noise and irrelevant details from the analysis by simply clicking on them.

This algorithm eliminates the manual, trial-and-error work common in most of today's image processing software. The degree of clarity and simplicity is unparalleled which makes Pixcavator especially suitable for beginners.

For a detailed exposition of the algorithm and the science behind it, visit our support wiki at [Pixcavator.com](http://Pixcavator.com).

## Quick Start

Launch Pixcavator by double clicking the program icon.

Currently, Pixcavator has three tabs.

- The **Analysis** tab allows the user to load the image, shrink it (if necessary), and launch analysis.
- The **Tools** tab allows the user to manipulate the image using common image processing tools and special effects.
- The **Output** tab allows the user to view, explore, and save the output data and the analyzed image.

You can explore the capabilities of the program by analyzing and manipulating the image with just a few clicks. Choose image *coins.gif* supplied with the software. Press the **Run** button. In just a few seconds you will be taken to the **Output** tab. The image is displayed on the left. To capture the coins, you need to move the sliders on the left to

appropriate positions. Try 1200 for size and 110 for contrast. Now, each coin is captured inside a contour.

The following is also available to you.

- On the right you will see the list of the coins, their locations, sizes, and other data.
- To see where each coin is listed, uncheck the box in the beginning of a row. A contour will disappear! Check the box again – the contour will reappear.
- If you click on a contour within the image – while holding **Ctrl** – the contour will disappear and the corresponding row will become unchecked.
- Some buttons are explained in the image below.

The screenshot shows the Pixcavator IA interface. On the left, a coin image is displayed with green contours around it. On the right, a table lists the detected objects. Below the table are various control panels for image analysis.

ID	Type	Location	Size	Perim.	Round.	Gray	Contrast	Dim.	ID
<input checked="" type="checkbox"/>	L	(235, 170)	1875	163	88	213	81	40x40	1
<input checked="" type="checkbox"/>	L	(149, 208)	2742	196	90	183	51	49x49	2
<input checked="" type="checkbox"/>	L	(36, 106)	2637	191	90	189	57	47x47	3
<input checked="" type="checkbox"/>	L	(265, 102)	1851	161	89	213	81	40x40	4
<input checked="" type="checkbox"/>	L	(216, 70)	2528	188	90	187	55	47x47	5
<input checked="" type="checkbox"/>	L	(55, 49)	1838	161	89	189	57	40x40	6
<input checked="" type="checkbox"/>	L	(148, 33)	2504	187	90	182	50	46x46	7
<input checked="" type="checkbox"/>	L	(174, 119)	2583	190	89	175	44	47x47	8
<input checked="" type="checkbox"/>	L	(109, 84)	1813	159	90	137	14	39x39	9
<input checked="" type="checkbox"/>	L	(95, 145)	2690	193	90	175	54	48x48	10

Callouts from the image:

- Check or uncheck rows in the table by clicking the contours while holding **Ctrl**.
- Push **Color** objects to randomly color the marked objects.
- Push **Hide contours** to see the original image.
- Push **Isolate Objects** to clear everything but the selected objects.

Fig. 1. Coins.gif has been analyzed.

More detailed instructions are provided in the following sections.

## Load and view an image

Start at the **Analysis** tab.

Select an image file from your hard disk by using the **Choose image...** button on the right. Most popular formats are supported: JPEG, BMP, PNG, GIF, TIFF.

The image will appear in the window.

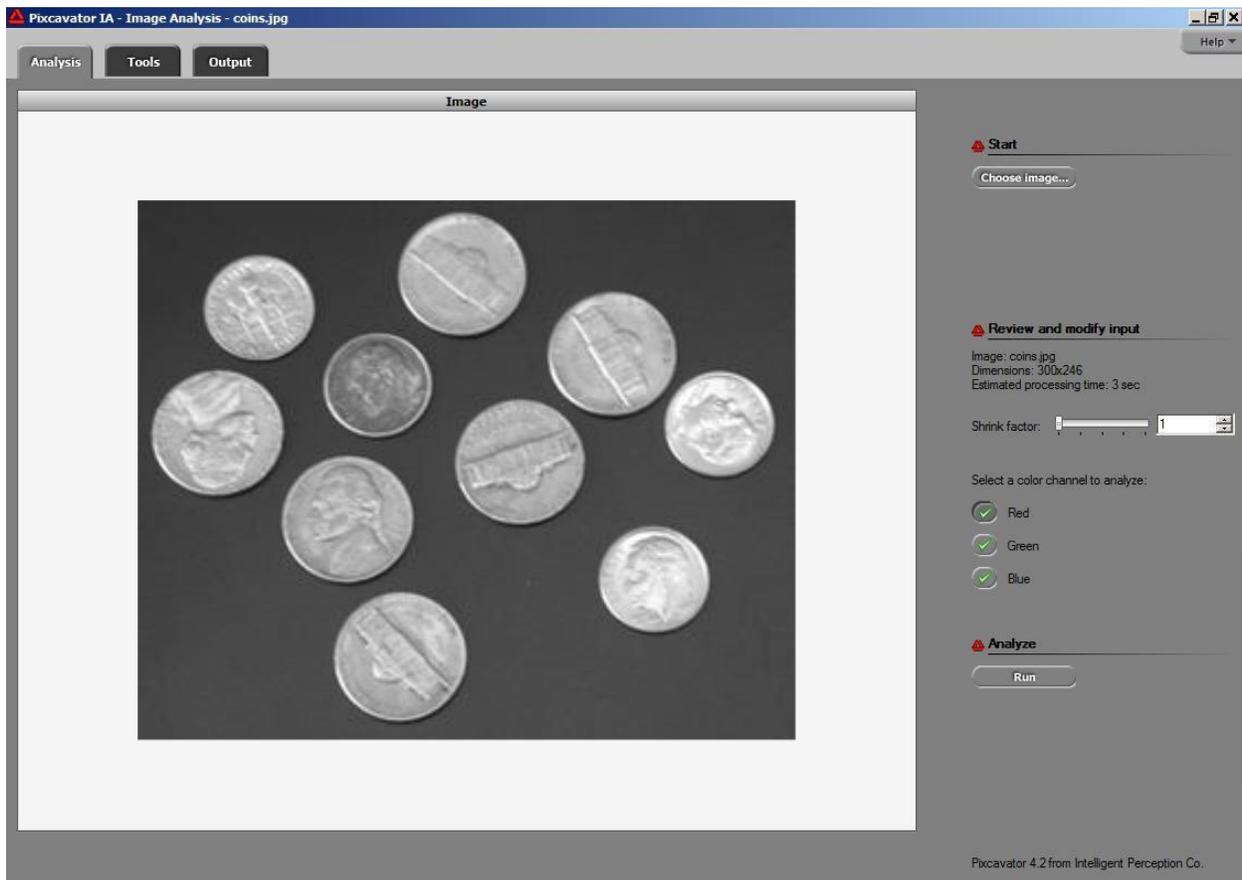


Fig. 2. The **Analysis** tab.

- You can pan the image using the left button of your mouse.
- The right button provides you with a magnification tool.

For color images you should also decide which channel you want to be analyzed. There are three color channels: red, green, and blue. By default the red channel is chosen. To better understand your options, keep in mind this fact: a bright red circle on a white background may be invisible in the red channel.

Note: when you open a new image, the previous analysis data is discarded.

Analysis of large images will take longer. But smaller details within the image may often be of relatively low interest. If this is the case, consider shrinking the image. For that, use the **Shrink image** slider. For example, if you set the slider at 2, the image size

will be reduced by 50% in either dimension. As a result, the processing time will be cut by a factor of 4.

The estimated processing time (2.4 GHz, Pentium 4) is displayed on the right. Simpler images take less time, complex more. For your convenience, the shrink slider is present to the value that ensures that the estimated processing time is under 16 seconds. You may choose this option for initial analysis of a large image - before you commit yourself to a longer wait.

## Start analysis

Process the image by pressing **Run** in the **Analysis** tab.

Initially, the image will be analyzed with settings chosen automatically based on the size of the image. You can change the setting later – it won't require re-processing the image.

As the image is being processed, a message is displayed with the “Cancel” button, just in case.

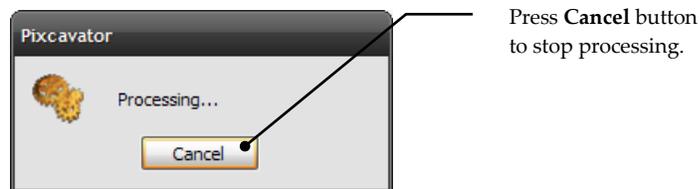


Fig. 3. This dialog box is displayed during processing.

Once the processing is over, you are taken to the **Output** tab.

## Select settings for further analysis

There are several heading in the **Output** tab.

The results of the initial – automatic – analysis may be unsatisfactory. In the image below, instead of the coins the contours capture small features on the coins.

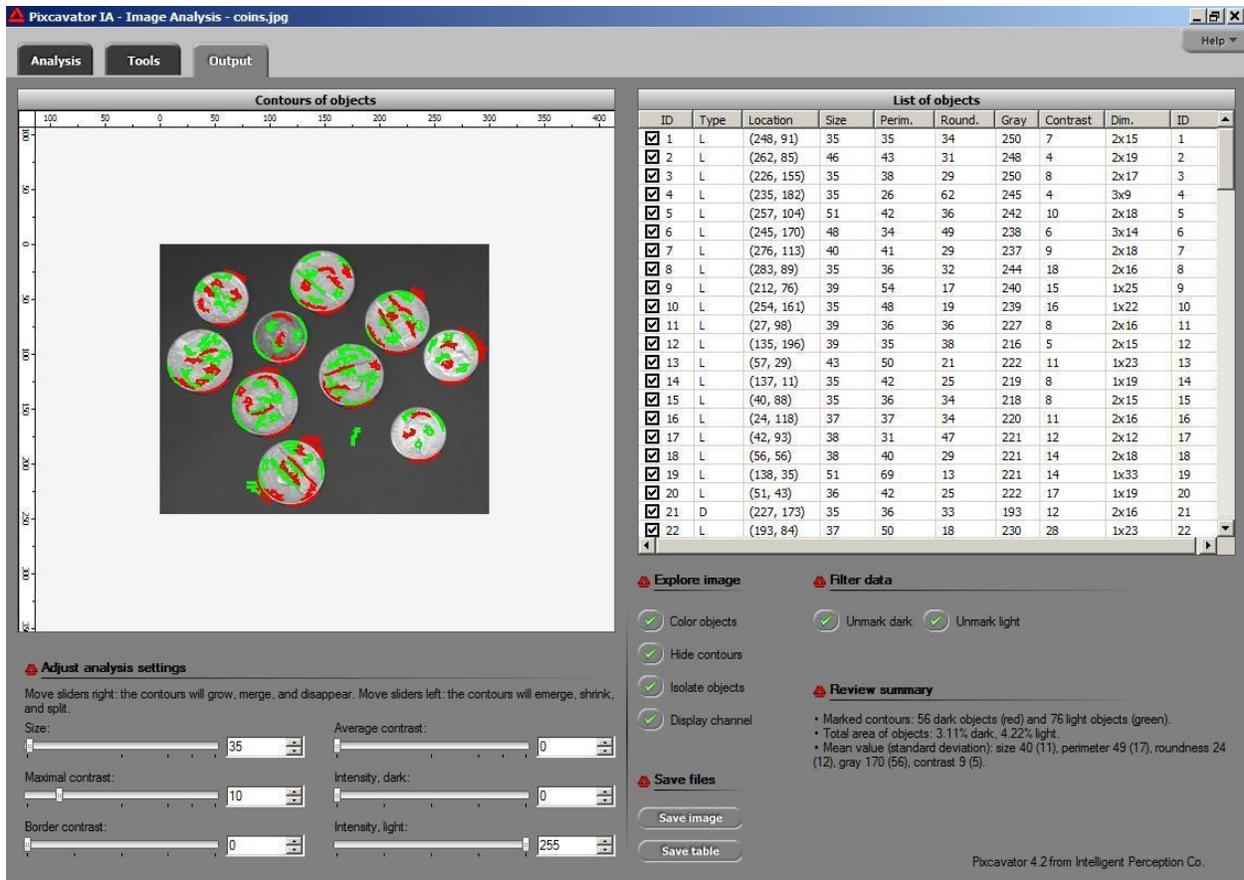


Fig. 4. The **Output** tab: the initial settings did not capture the coins.

To improve the results proceed in the semi-automatics mode.

There are three *sliders* under **Adjust analysis settings** on the left that allow you to quickly re-analyze the image with new settings.

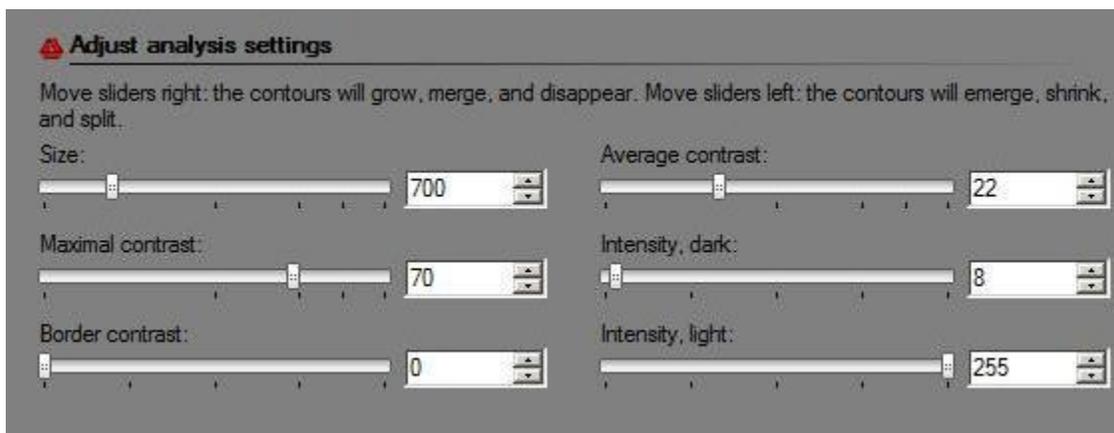


Fig. 5. The sliders.

Start with the first two sliders on the left. They correspond to two main measurements – size and contrast – of objects in a gray scale image. The objects that fall below these thresholds will be ignored by the analysis procedure. These features won't have contours.

First, choose **Size**. For example, if you choose 100, only the objects containing 100 or more pixels will be captured.

Second, choose **Maximal contrast**. For example, if you choose 20, only the objects surrounded by an area with gray level that differs from that of any pixel within the object by 20 or more will be captured. There are 256 levels of gray.

For *coins.gif* included with the software, move the size slider to 1200 and the contrast slider to 110. Then all 10 coins are perfectly captured as shown below.

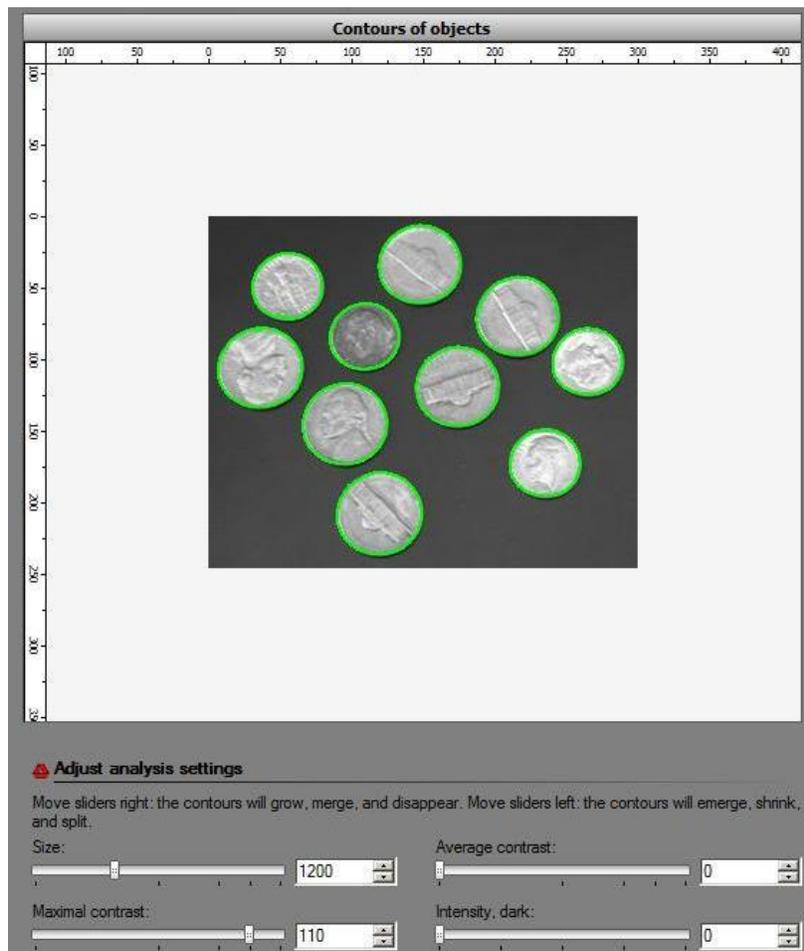


Fig. 6. The coins are captured.

The next two sliders work similarly but take into account the **Border contrast** and the **Average contrast** of the object relative to its surroundings.

Another way of looking at these three settings is the following. The objects are allowed to grow – from one level of gray to the next - until they are both large enough and have high enough contrast. To utilize this understanding, the third slider was introduced in version 3.1.

In the example with *coins.gif*, 700-70 settings for size and contrast do not provide good results. However, moving the third slider to 100 solves the problem, below.

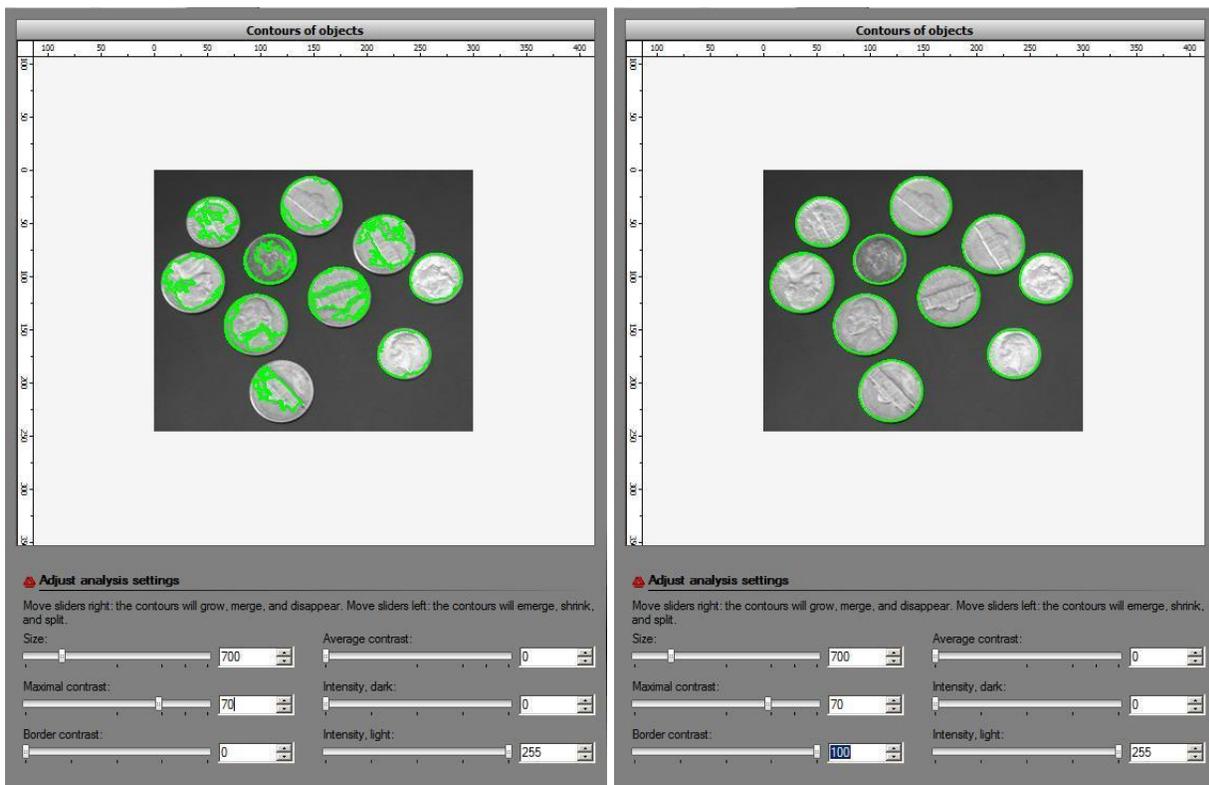


Fig. 7. The use of the **Border contrast** slider.

As you can see, it is possible that very similar results are achieved under different settings.

The last two sliders simply “threshold” the image. For example, if you set **Intensity, dark** to 100, the contours of dark objects will be the intensity equal to exactly 100. If you set **Intensity, light** to 100, the contours of light objects will be the intensity equal to exactly 155 (here  $155=255-100$ ). It was set this way in order to ensure that contours grow as you move any of the six sliders from left to right.

For more guidance on how to use these sliders, visit our support site [Pixcavator.com](http://Pixcavator.com).

## Explore output

In the **Output** tab the updated image – including contours of objects – is displayed on the left. Dark objects are outlined with red and light with green.

As before, you can pan with the left button of your mouse and magnify with the right button.

If you click within the image while holding **Ctrl**, the nearest object to your mouse will become marked if it's unmarked, and vice versa. If, in addition, you move the mouse, the objects close to the rectangle spanned this way will be marked (or unmarked). As a result, the corresponding contours will appear (or disappear).

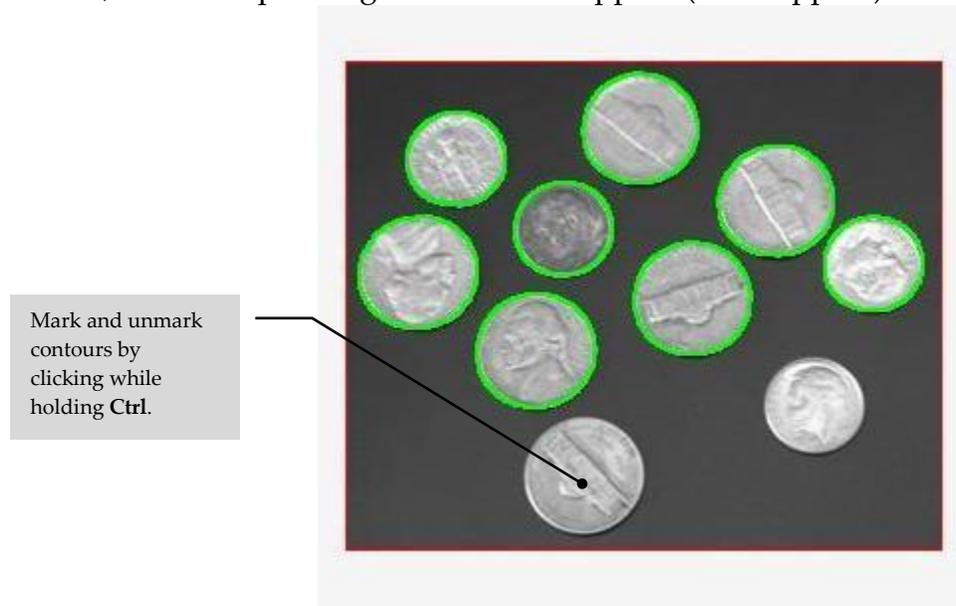


Fig. 8. Two coins are unmarked.

On the right, a table is displayed listing all objects in the image captured by the software. For each object the following data is displayed:

- type: light or dark,
- location of the centroid,
- size (area in pixels),
- perimeter,
- roundness,
- gray (intensity),

- average contrast (note that the second slider is contrast, not average contrast),
- dimensions (thickness and length).

For more details on these measurements, visit our online tutorial.

List of objects								
ID	Type	Location	Size	Perim.	Round.	Gray	Contrast	Dim.
<input checked="" type="checkbox"/> 1	L	(265, 101)	1784	163	84	215	48	40x40
<input checked="" type="checkbox"/> 2	L	(235, 173)	1812	160	89	214	56	40x40
<input checked="" type="checkbox"/> 3	L	(148, 34)	2450	185	90	182	27	46x46
<input checked="" type="checkbox"/> 4	L	(36, 106)	2595	198	83	189	39	49x49
<input checked="" type="checkbox"/> 5	L	(119, 208)	2705	194	90	182	32	48x48
<input checked="" type="checkbox"/> 6	L	(55, 49)	1803	162	85	189	44	40x40
<input checked="" type="checkbox"/> 7	L	(174, 119)	2554	191	88	175	32	47x47
<input checked="" type="checkbox"/> 8	L	(95, 145)	2645	192	90	174	32	48x48
<input checked="" type="checkbox"/> 9	L	(216, 70)	2511	188	89	186	46	47x47
<input checked="" type="checkbox"/> 10	L	(109, 84)	1813	159	90	137	14	39x39

Fig. 9. The list of objects in the **Output** tab.

At any time the user can use the sliders described above. The table and contours are updated every time you move these sliders. This way the user can find the best setting very quickly.

Sometimes just moving the sliders still leaves noise or irrelevant objects captured and recorded in the table. In this case, manual editing – clicking on objects to uncheck them – may be necessary.

Just like with any spreadsheet, if you click a column header, the rows will be sorted from high to low or low to high with respect to the entries in this column.

To mark and unmark a row in the table, check and uncheck the square in the beginning of the row. If an object is marked or unmarked in the table on the right, a contour appears or disappears around it in the image on the left, and vice versa.

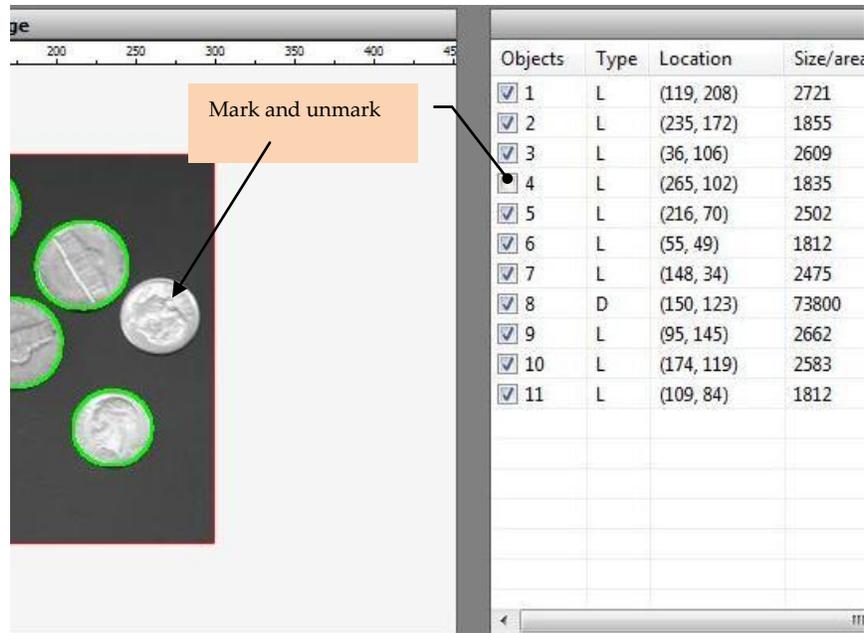


Fig. 10. A coin is unmarked by un-checking a row in the table.

As you move your mouse around the image you the data of the nearest object appears below the image. The contour of the object becomes blue.

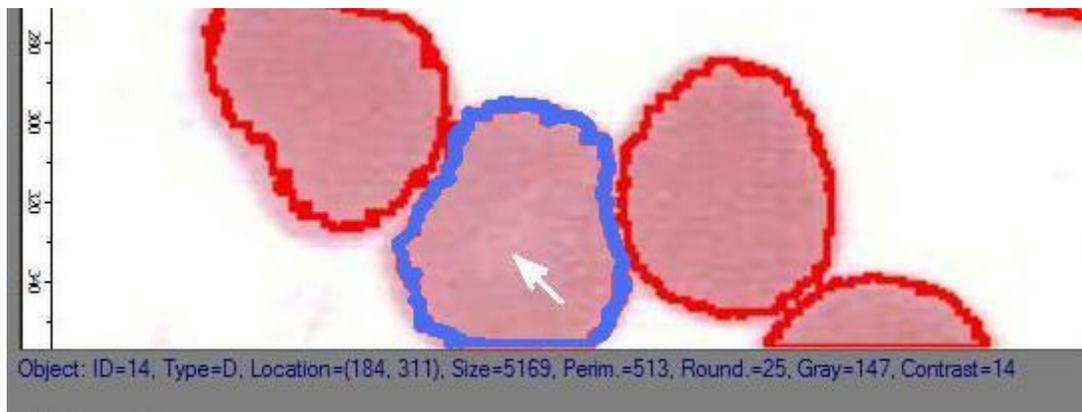


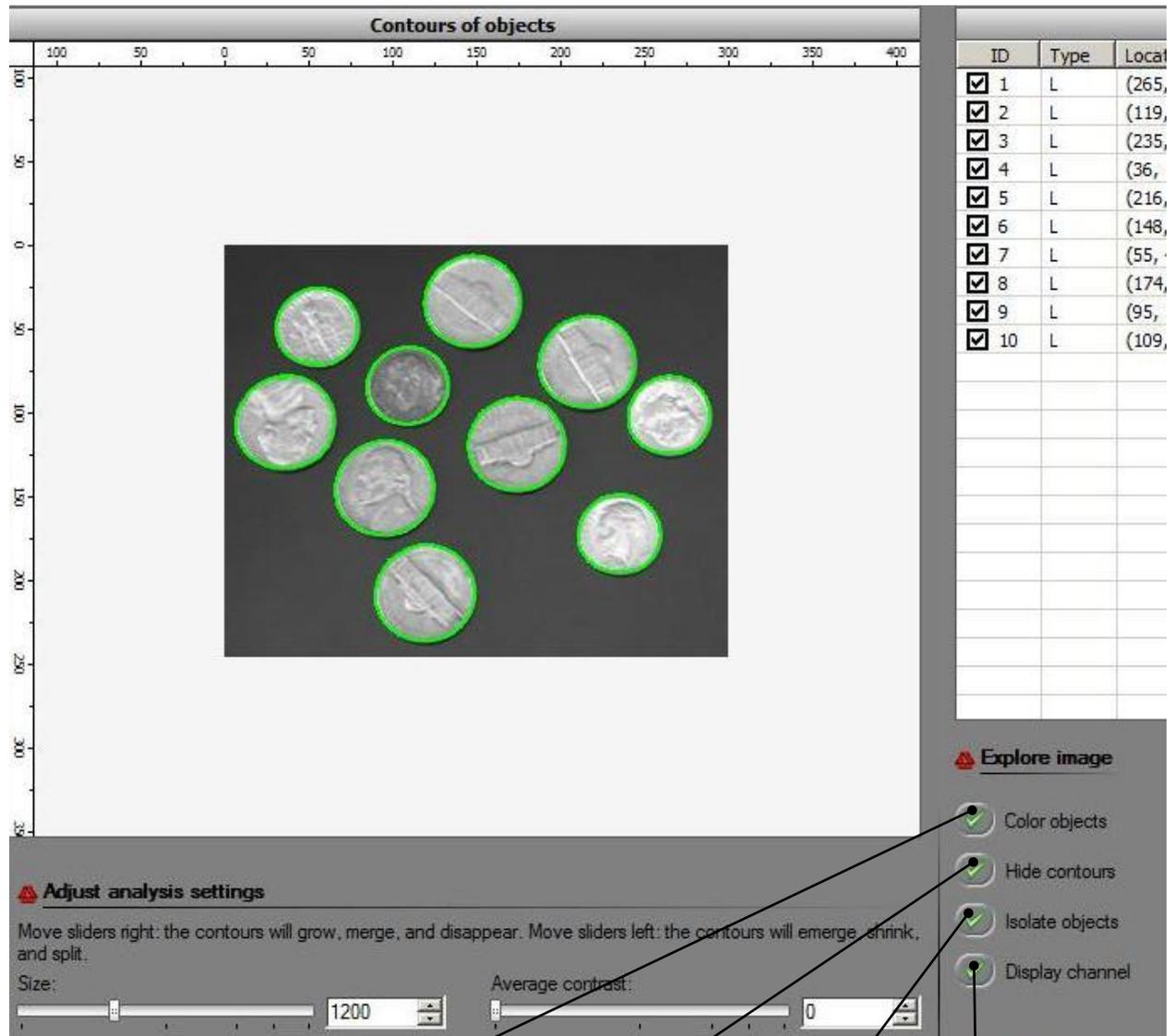
Fig. 12. The characteristics of the object are shown.

The buttons under **Filter data** header allow you can mark and unmark groups of objects. You can either **Unmark dark** objects or **Unmark light** objects. These commands will override all prior manual markings. There will be more tools here in the upcoming releases.



Fig. 11. The **Filter data** header.

Under **Explore image** header you will find four buttons that will help you to better understand the image and the output data.



Push **Color objects** in order to randomly color the marked objects.

Push **Hide contours** to see the original image.

Push **Isolate Objects** to clear everything but the selected objects.

Push **Isolate Objects** to clear everything but the selected objects.

Fig. 13. The **Output** tab, **Explore image** header.

You can **Color objects** in the image by filling the contours of marked objects with random colors. The unmarked objects remain unchanged.

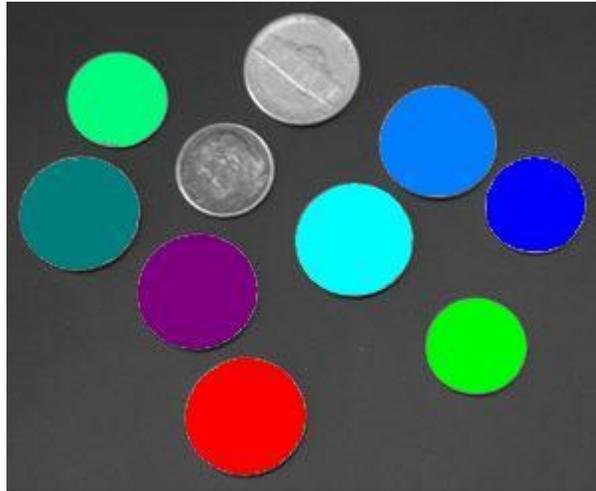


Fig. 14. The eight marked coins have been colored.

You can erase everything outside the marked objects by pressing **Isolate objects**.



Fig. 15. Two unmarked coins have been removed.

You can **Hide contours** to see the original image (provided the objects aren't colored).

You also can **Display channel** that is analyzed as a grey scale image. If the image was shrunk, the shrunk version will be shown.

In the right lower corner you see the analysis summary under **Review summary**. Keep in mind that only the marked objects are taken into account.

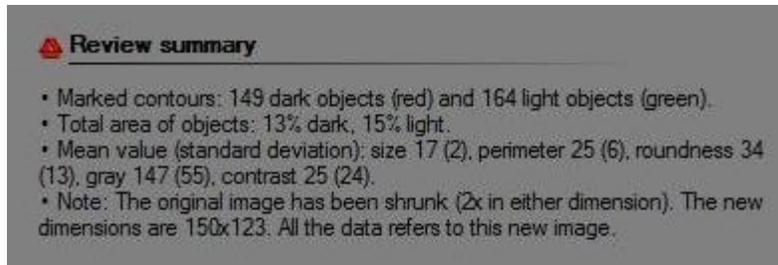


Fig. 16. The **Review summary** header.

The first item is the number of dark objects and the number of light objects found in the image.

The second item is the total area of all dark objects and the total area of all light objects. If you use this information for measuring objects, subtract light from dark or vice versa.

The third item is the mean values (averages) and standard deviations of the main characteristics of the objects. The most important are size and contrast.

The fourth item appears only if the image has been shrunk.

## Save Files

You can save the displayed image – with all marked and unmarked contours, colored or isolated objects – by pressing **Save image**. Most popular formats are supported: JPEG, BMP, PNG, GIF, TIFF. You will be prompted with the name that contains the name of the original image, Pixcavator's version number, the shrunk factor, and the simplification settings.

Finally, you can export the output table to Excel by pressing **Save table**. You will be prompted with the name of the original image and other settings as above.

## Modify the image with image processing tools

One may want to enhance the image prior to analysis to improve the results. Alternatively, the image may be degraded to test the robustness of analysis. There are also other features.

Go to the **Tools** tab. The image on the left is the original and the one on the right will show the effects of image processing. You can modify the original image before or after analysis.

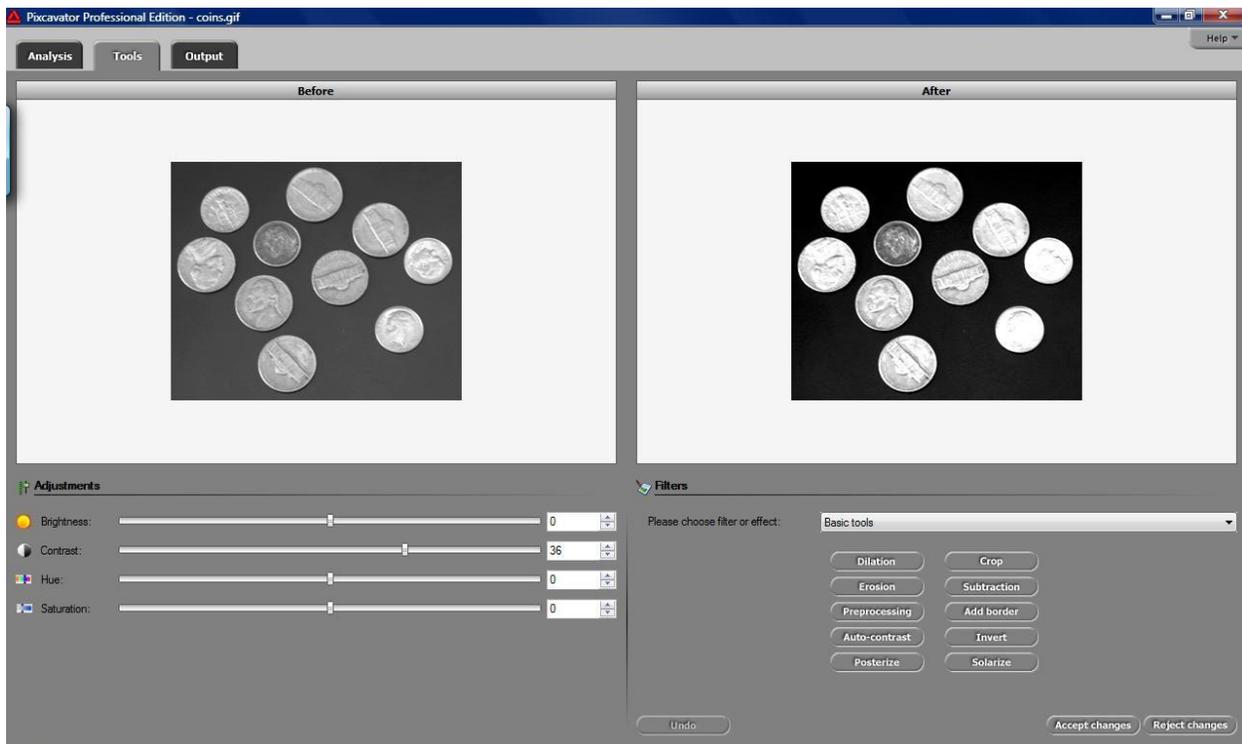


Fig. 17. The **Tools** tab.

You can adjust the image's **Brightness**, **Contrast**, **Hue** and **Saturation** by using the sliders on the left. This may *enhance the image*.

On the right, there is a drop down menu for **Filters and effects**.

The most important tools for image analysis are at the top – **Basic tools**.

- **Erosion** thins dark areas and **Dilation** thickens them. These may improve the accuracy of analysis by eliminating scratches and other imperfections.
- **Preprocessing** combines dilation and erosion. However, an image enhanced in this way may appear to be blurred.
- **Auto-contrast** will make the image appear sharper.
- To **Crop** the image you should outline a rectangle within the image window on the right with your mouse as you hold the **Ctrl** key.
- To see the effect of image simplification use **Subtract**. It will show the difference between the original and updated images.
- If you want *all* light objects counted including those adjacent to the border of the image, press **Add border**.

**Edge detector** is a standard *image analysis* tool. It finds the regions in the image where colors vary the most, such as a shift from dark to light.

Other filters *add imperfections* to the image: **Noise, Blur, Median filter, Dust and scratches**. They can be used to verify whether the results of image analysis remain unchanged after the image is degraded by these operations.

The rest of the items in this menu add *artistic effects* to the image.

The image on the left will always display the image you started with until you press **Accept changes**. When you do, this image, and the original image to be analyzed or processed image to be saved, is replaced with the new image.

You can **Undo** the recent changes or **Reject changes** and return to the original.