PhenoCapture

User Manual

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2. System requirements

- Operating system: Microsoft Windows XP, Vista, 7, 8, and 10 (Both 32 & 64 Bit OS supported)
- CPU: 800 MHz or higher (Recommend 2 GHz or better)
- Ram: 1 GB or higher (Recommend 2 GB or more)
- Disk storage space: 10 MB free space for installation

3. Software installation

PhenoCapture software is provided as a compressed file (zip or 7z). After extracting it, run 'PhenoCapture.exe'. Users may have to install Microsoft .NET (dot net) framework 4.0 or higher.

4. Program menu

The 'Device' menu has the function to connect imaging devices and change imaging settings. The 'Image' menu is used to change the image size or rotation, color adjustment, noise removal, etc. The 'Color' menu has color-related functions, including gray scaling, color channel extraction, and color conversion. The 'Processing' menu has functions such as binarization and edge detection. The 'Binary' menu has various binary operations. The 'Analysis' menu has functions to extract image information. The 'Tool' menu has various tool functions, including batching processing, image transmission functions, etc.

Device Edit Sconnect to HD Camera 9 Undo Ctrl+Z >> Connect to Camera (only for Windows 7 or below) Ċ1 Redo Ctrl+R P Record HD video Ctrl+C Сору Select Scanner or TAWIN imaging devices Ctrl+V 2 Paste Acquire image Unselect * Capture Set selection box size Video source Put to ۲ Video format Get from 🔌 Clear Drag-drop image box Disconnect Image Color 🖶 Flip ۲ 🍫 🛛 Split RGB to ۲ Rotate Delete channel ۲ Rotational alignment by line shape Gray from ۲ Resize Convert to rg Chromaticity Crop 1 2° Gray scaling Ctrl+G Brightness and contrast -Ctrl+I Invert 8 Color range selection Box averaging B ۲ Gaussian filter ۲ Fill region . Sharpen 3x3 ۷, Change color 💈 Overlay image to Workspace image Gray to Color Emboss Dithering to black and white image ۲ Processing Binary Manual binarization **养**方 Skeletonize Adaptive binarization F C Outline = Multi-S ۲ Erode

Multi-Step thresholding		Frede outline		
Erode +		Dilate outline		
Dilate + Hide outlines	۲	Boundary detection in region	•	
Canny edge detection	-	Gap filling Remove single pixels		
Average image Subtraction (Image Buffer 1 - Workspace)		Hough transform for lines Hough transform for circles		

• Dilate

В C

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An	alysis	То	l		
	Line profile	10 k	Batch processing	F4	
	Histogram	0	Time lapse image capture		
2	Region extraction (only for BW)	Ø	Automatic image downloa	Automatic image downloader	
••••	Color quantification	۲	Online live view web service		
123	Pixel counter	۵	FTP image upload service		
	Average color value	*	Remote webcam server		
#	Multiple array analysis	31	Remote webcam client		
~~	Length measurement	33	Quick animation		
1	Custom coordinate	<u>***</u>	Create Video or Animated Gif file from image	es	
2	Point location recorder	B	Batch Text Writer		
٠	Edge location measurement		Extract frames from Video file		

Main menu	Submenu	Description
File	Open	Open an image file
		Supported image format: bmp, gif, jpg,
		jpeg, png, tiff, tif
	Saveas	Write the current image to an image file
		Supported image format: bmp, gif, jpg,
		jpeg, PNG, tiff, tif
	Print	Print the current image
	Exit	Terminate the program
Device	Connect to HD Camera	After selecting a camera, it allows a user to
		view a real-time image. This is necessary to
		begin image capture
	Connect to Camera (only for	It can be used when using an incompatible
	Windows 7 or below)	old camera
	Record HD video	Record as a video
	Select Scanner or TWAIN imaging	It allows you to capture an image after
	device	connecting a scanner or a device that
		supports the TWAIN interface
	Acquire image	Acquire image from scanner or device that
		supports the TWAIN interface
	Capture	Capture an image from the currently active
		camera
	Video source	It allows a user to select a camera from
		among multiple cameras
	Video format	Set video format
	Disconnect	Disconnect the currently active camera
Edit	Undo	Back to the previous image
	Redo	Restore image that previously has been
		undone
	Сору	Copy image to the clipboard
	Paste	Paste image to the workspace
	Unselect	Unselect an ROI (region of interest)
	Set selection box size	Set a selection box size
	Put to	Put the image to the drag drop box
	Get from	Get an image from the image buffer
	Clear Drag-drop image box	Clear the drag-drop image box
Image	Flip	Flip image
	Rotate	Rotate image
	Rotational alignment by line shape	Rotation image in line with the line
	Resize	Resize image
	Crop	Crop image
	Brightness and contrast	Adjust image brightness and contrast

Table 1. Summary of menu functions

	Box averaging	Apply a blur filter (neighborhood averaging
		filter)
	Gaussian filter	Apply Gaussian filter
	Sharpen 3x3	Sharpen image (filter box size: 3x3)
	Overlay image to Workspace image	Overlay one of the images in the drag-drop
		box onto the workspace image
	Emboss	Emboss image
	Dithering to black and white image	Dithering image to a binary image
		(Options: Ordered color, Floyd Steinberg)
Color	Split RGB to	Split a color image to a designated color
	•	channel
		(Color channel options: red, green, blue,
		hue, saturation, intensity, cyan, magenta,
		yellow, K black, L, a, b, rg chromaticity
		red, green, blue)
	Delete channel	Remove one of the red, green, and blue
		color channels from the color image
	Grav from	Convert one of the red, green, and blue
		color channels to a gray image
	Convert to rg Chromaticity	Convert a color image to an rg
		Chromaticity
	Grav scaling	Convert a color image to a grav image
	Invert	Invert image
	Color range selection	Extract pixels similar to a specific color
		from an image
	Fill region	Paint the current image with the specified
		color
	Change color	Change nixels of a specific color in the
		image to a different color
	Grav to Color	Convert a gray image to a color image
	Gruy to Color	displayed in red and blue
Processing	Manual binarization	After specifying the threshold value, the
Tiocessing		color image is converted to a binary image
	Adaptive hiparization	Convert a color image to a binary image
	Acaptive offanization	using an adaptive thresholding algorithm
	Multi-step thresholding	Reduce the number of colors with a stair.
	Wulli-step unesholding	shaped look-up-table
	Frada	Apply grade filter
	Dilata	Apply clode filter
	Dilate Llida autlinas	Appry diate inter
	Alde outlines	A sub-Course la Claste laterte la
		Apply Canny edge filter to detect edges
	Edge detection	Apply edge detection filters
		(Filter options: homogeneity, Sobel, left-
		hand edge, upper left-hand edge)

	Average image	The average image is generated from
		multiple images
	Subtraction (Image Buffer 1 -	Create a differential image between the
	Workspace)	workspace image and image the buffer of
		the drag drop image box
Binary	Skeletonize	Extract skeletal lines from the binary image
	Outline	Extract the borderline from the binary
		image
	Erode outline	Erase the borderline of white pixels in the
		binary image
	Dilate outline	Add a white pixel outline to the binary
		image
	Boundary detection in region	Detect bounders in the binary image
	Gap filling	Fill the gap
	Remove single pixels	Remove single white pixels
	Hough transform for lines	Perform Hough transform to detect lines
		(experimental)
	Hough transform for circles	Perform Hough transform to detect circles
		(experimental)
Analysis	Line profile	Extract color along a straight line
1	Histogram	Calculate color histogram
	Region extraction (only for BW)	Extract regions in the binary image
	Particle color analysis	Extract regions in the ondry image Extract particles from a color image and
		calculate color values
	Color quantification	Count the number of nivels per color
	Pixel counter	Count the number of pixels with a specified
		color
	Average color value	Count the average color value
	Multiple array analysis	Calculate color values at various locations
	Wuttiple array analysis	with a grid-type ROI
	Length maggirgment	Calculate the distance between two
	Length measurement	
	Custom acordinate	Extract the location of the points in the
	Custom coordinate	extract the location of the points in the
	Doint location recorden	Extract the leastion of the points by
	Point location recorder	Extract the location of the points by
		Entrant the least in a fither winter allow the
	Edge location measurement	Extract the location of the points where the
T 1		color changes rapidly
1001	Bach processing	Performs multiple tasks of image
		processing sequentially
	I ime-lapse image capture	Take time-lapse images
	Automatic image downloader	Download images from a specific IP
		address or web address

	Online live view web service	Provide camera video streaming to view real-time images on the web browser
	FTP image upload service	Upload images to FTP server regularly
	Remote webcam server	Build a webcam server so that other PCs
		can see the camera image on the server-side
	Remote webcam client	Connect to the webcam server and
		download the image
	Quick animation	Show animation from $2 \sim 5$ images and
		create an animated GIF file
	Create Video or Animated Gif	Create a video or animated GIF file from
	from images	multiple images
	Batch Text Writer	Write text sequentially on multiple images
	Extract frames from Video file	Extract frame images from a video file
View	Zoom in	Zoom in the current image
	Zoom out	Zoom out the current image
	Zoom 100%	Set the current image zoom to 100%
	Zoom to fit	Automatically set the magnification of the
		current image
	Multiple ROIs	Show the Multiple ROIs window
	File manager	Show the File manager window
	Drag Drop Image Box	Show the Drag Drop Image Box window
	Drag Drop Image File Box	Show the Drag Drop Image File Box
		window
	Toolbox	Show the toolbox window
	Reset window layout	Reset the current window layout
Help	About	The logo window is displayed
	Visit our website	Open a web browser and connect to
		www.phenocapture.net

5. Device control

De		Connect to HD	After selecting a camera, it allows a
» » ¶	Connect to HD Camera Connect to Camera (only for Windows 7 or below) Record HD video	Camera	is necessary to begin image capture
* •	Select Scanner or TAWIN imaging devices Acquire image Capture Video source Video format Disconnect	Connect to Camera (only for Windows 7 or below)	It can be used when using an incompatible old camera
		Record HD video	Record as a video
		Select Scanner or TWAIN imaging device	It allows you to capture an image after connecting a scanner or a device that supports the TWAIN interface
		Acquire image	Acquire image from scanner or device that supports the TWAIN interface
		Capture	Capture an image from the currently active camera
		Video source	It allows a user to select a camera from among multiple cameras
		Video format	Set video format
		Disconnect	Disconnect the current active camera

5.1 Camera connection and capture

The 'Device' menu on the main toolbar provides the ability to connect to capture devices. The user can click 'Connect to HD Camera' in the 'Device' menu. The user can also connect to the capture device by clicking the 'Connect' button on the main toolbar.

Phen	oCapture	7.0 Bu	ild 887								
<u>F</u> ile	Device	<u>E</u> dit	<u>I</u> mage	Color	Proce	essing	Binary	Analysis	Tool	View	<u>H</u> elp
6) 📀) 🖶 🕩	Сору	🚨 Paste	» Con	nect	* Cap	ture Zo	om 100%	100	- 🕍 P	rofile 🛛 🐗
Toolbox	ĸ	ſ	Drag-dro	p image b	ox	Works	pace "Def	ault.bmp"	[500x500] 100%	
≫ Acc	quire										
2 Par	n mode										

The user can select one of several cameras and then set values including the image size and frame rate soon.

Juive view	× Properties	×
Lock sync 🔲 Always on top	Pin Property	
Select capture device Logitech HD Pro Webcam C920 Logitech HD Pro Webcam C920	Color Space / Compression MJPG • Output Size 1920 × 1080 • Frame Rate 30 FPS •	
	ОК Салс	el <u>Apply</u>

After connecting the camera, the user can view the image in real-time. Press the 'Capture' button on the main toolbar to take the image.



5.2 Camera configuration

When connected to the camera, the 'Video source' menu in the 'Device' menu is activated. Clicking it brings up a window to change various options of the camera. To set all options automatically, press 'Set All Auto' button. To manually adjust the value, press 'Set All Manual' button. The camera settings can be saved as a file by pressing the 'Save setting' button. To reload the saved camera settings file, press the 'Load setting' button.

Video source				>	Video source			
Image processing Camer	a contro	a]			Image processing	Camera control		
				Auto				Auto
Brightness	0	4) 255	128	Pan	-10 🔳	<u>}</u> 10	▼ 0
Contrast	0	4	▶ 255	√ 128	Tilt	-10 (▶ 10	▼ 0
Hue	0	4) 255	☑ 0				
Saturation	0	4) 255	✓ 128	Roll	-10 4	▶ 10	Io. 10
Sharpness	0	4	▶ 255	IZ8 128	Zoom	100 4	▶ 500	500
Gamma	0	4	▶ 255	□	Exposure	-7 () -1	☑ -4
Gain	0	4) 255	▼ 0				
White balance	200	0	▶ 6500	▼ 5352	Iris	-/ 4	<u>}</u> -1	∽ 0
Backlight compensation	n O	4	→ 1	▼ 0	Focus	0 4	▶ 250	☑ 0
Set All Auto Set A	II Manu	al Save setti	ng Load setting	ок	Set All Auto	Set All Manual Save setting	Load setting	OK

5.3 Image acquisition from scanner

Select the scanner from the 'Select Scanner or TWAIN imaging device' menu and press the Acquire image to load the image being scanned.

5.4 Video recording

Click the 'Record HD video' menu to save the camera image as a video file. After specifying the folder to save the video file, the window for the compression codec and various settings will appear first. Users can use the option to automatically create new video files at regular intervals. The following codecs are recommended for video recording codecs. Users may have to install codecs before using them. By the way, since PhenoCapture does not provide a separate video codec, users will have to install the codec themselves.

-Microsoft Window Media Video 9 (WMV): Very high quality and recommended for research purposes

-Microsoft MPEG-4 VKI Codec V1/V2/V3: The image quality is slightly lower than WMV, but the video file size is smaller than WMV due to its high compression rate.

-Lagarith lossless: A lossless compression codec with low compression rate but excellent real-time compression performance (FPS)



6. Image adjustment

			Flip	Flip image
Im	age Flip	•	Rotate	Rotate image
	Rotate Rotational alignment by line shape Resize Crop		Rotational alignment by line shape	Rotation image in line with the line
	Brightness and contrast			
	Gaussian filter	,	Resize	Resize image
Z	Overlay image to Workspace image	_	Crop	Crop image
	Emboss Dithering to black and white image	۲	Brightness and contrast	Adjust image brightness and contrast
			Box averaging	Apply a blur filter (neighborhood averaging filter)

Gaussian filter	Apply Gaussian filter
Sharpen 3x3	Sharpen image (filter box size: 3x3)
Overlay image to Workspace image	Overlay one of the images in the drag-drop box onto the workspace image
Emboss	Emboss image
Dithering to black and white image	Dithering image to a binary image (Options: Ordered color, Floyd Steinberg)

6.1 Brightness and contrast

The user can adjust the brightness and contrast of the image.



6.2 Overlay image

The function overlays one of the images in the drag-drop box onto the workspace image. Insert the image to be overlayed into the drag-drop image box, select the 'Image in Drag-drop image box' in the 'Overlay image' window, and select 'Transparent color'. Then, press the 'OK' button to get the final overlayed image.



Image to overlay

Workspace image

Final image



6.3 Emboss

This feature makes the image emboss, making it look as if the image is projecting or entering.



Original image



6.4. Dithering

The user can convert a color image to a binary image consisting only of black and white pixels. Two algorithms are provided: Ordered color and Floyd Steinberg.



7. Color processing

Co	lor Split RGB to Delete channel Gray from Convert to rg Chromaticity Gray scaling Invert Ctrl+G Invert Ctrl+I	Split RGB to	Split a color image to a designated color channel (Color channel options: red, green, blue, hue, saturation, intensity, cyan, magenta, yellow, K black, L, a, b)
<i>°</i>	Color range selection Fill region Change color	Delete channel	Remove one of the red, green, and blue color channels from the color image
	Gray to Color	Gray from	Convert one of the red, green, and blue color channels to a gray image
		Convert to rg Chromaticity	Convert a color image to an rg Chromaticity
		Gray scaling	Convert a color image to a gray image
		Invert	Invert image
		Color range selection	Extract pixels similar to a specific color from an image
		Fill region	Paint the current image with the specified color
		Change color	Change pixels of a specific color in the image to a different color
		Gray to Color	Convert a gray image to a color image displayed in red and blue.

7.1 Color extraction

The 'Split RGB to' menu can be used to split a color image into specified color channels. The supported color spaces are RGB, HSI, CMYK and Lab.



7.2 Gray scaling

The user can convert a color image to a black and white image with the 'Gray scaling' menu. The formula used for gray scaling is as follows.

 $Gray = 0.299 \times Red + 0.587 \times Green + 0.114 \times Blue$

The original color image becomes a gray image by making the red, green, and blue channels of the color image equal to the calculated gray value.







7.3 Color range selection

The user can extract parts of a specific color in the image. After placing the mouse cursor on the image and clicking the mouse, the user can specify the color value of the 'Color of interest' and adjust the 'Tolerance' to set a similar color range. The algorithms for determining the color range are 'Absolute distance' and 'R2 distance'. Ref (reference) means the color value of the 'Color of interest'.

Absolute distance = $|R-R_{ref}| + |G-G_{ref}| + |B-B_{ref}|$

R2 distance = SQRT ($(R-R_{ref})^2 + (G-G_{ref})^2 + (B-B_{ref})^2$)



Original image







8. Image processing

Pro	ocessing Manual binarization Adaptive binarization Multi-Step thresholding		Manual binarization	After specifying the threshold value, the color image is converted to a binary image
• • B C	Erode Dilate Hide outlines Canny edge detection	•	Adaptive binarization	Convert a color image to a binary image using an adaptive thresholding algorithm
20	Average image Subtraction (Image Buffer 1 - Workspace)	-	Multi-step thresholding	Reduce the number of colors with a stair-shaped look-up-table
			Erode	Apply erode filter
			Dilate	Apply dilate filter
			Hide outlines	Remove outlines
			Canny edge detection	Apply Canny edge filter to detect edges
			Edge detection	Apply edge detection filters (Filter options: homogeneity, Sobel, left-hand edge, upper left-hand edge)
			Average image	The average image is generated from multiple images
			Subtraction (Image Buffer 1 - Workspace)	Create a differential image between the workspace image and image the buffer of the drag drop image box

8.1. Manual binarization

The user can convert the image to a binary image. After setting the threshold value, if the gray value of the image pixel is lower than the threshold, it is converted to black, and if it is higher than the threshold, it is converted to white value to obtain a binary image. This function applies to color images as well as gray images.



Original image



Manual binarization applied



8.2. Adaptive binarization

The user can convert the image into a binary image through the 'Adaptive binarization' that uses an adaptive thresholding algorithm. The user can set the processing box size, set whether the object to be detected is black or white, and specify the threshold level. The higher the threshold level is, the more sensitive it is, the more objects are detected.

Adaptive threshold	ding	×
Size of processing	box (Recommend bigger	than objects of interest)
80	J	
Color of objects of	interest	
O Black	White	Automatic
Threshold level %	(Recommend 86 as defaul	t)
	ОК	Cancel

Original image



Adaptive binarization applied



8.3. Multi-step level thresholding

The 'Multi-step thresholding' function reduces the color by applying a stair shaped look-uptable. If the 'Synchronize' is unchecked, the total number of colors to be converted for each R, G, B color can be set.

E Multi step Level thresholding	×
Synchronize	
	Red 4
	Green 4
	Blue 4
OK Cancel	

Original image



Multi step thresholding applied



8.4. Erode & Dilate

Erode and dilate are applied to color images. Erode enlarges the dark areas of the image and dilate enlarges the bright areas.

Original image



Eroded

Dilated



8.5. Hide outlines

This function is used to remove outlines with a specific color from an image. When removing the outline, it naturally removes the outline by replacing it with the average of the surrounding colors.

B Hide outlines	×	
Red 0 Green 255 Color of interest FFFFFF	Blue 0	
* Double click on Workspace	window to set color	
ок	Cancel	P
	6	

Original image

Outlines removed



8.6. Canny edge detection

Canny edge detection is a good algorithm for extracting contours from images. The user can adjust the extraction sensitivity by specifying the threshold value. The smaller the threshold value, the greater the extraction sensitivity. The default value is 100.



Original image



Canny edge detection applied



8.7. Average image

The "Average image" function creates an average image from multiple images. Users can set whether the average image they want to create is color or gray.

9. Binary processing

Bir	nary	Skeletonize	Extract skeletal lines from the binary image
劫 Ct	Skeletonize Outline Erode outline	Outline	Extract the borderline from the binary image
•	Dilate outline Boundary detection in region	Erode outline	Erase the borderline of white pixels in the binary image
	Gap filling Remove single pixels	Dilate outline	Add a white pixel outline to the binary image
٢	Hough transform for circles	Boundary detection in region	Detect bounders in the binary image
		Gap filling	Fill the gap
		Remove single pixels	Remove single white pixels
		Hough transform for lines	Perform Hough transform to detect lines (experimental)
		Hough transform for circles	Perform Hough transform to detect circles (experimental)

9.1. Skeletonize

In the binary image, skeleton lines are extracted from white pixel objects.







9.2. Outline

In the binary image, borderlines are extracted from white pixel objects.



Outline image



9.3. Erode & Dilate

Erode and dilate are applied to binary images. Erode enlarges the dark areas of the image and dilate enlarges the bright areas. By using erode and dilate properly, various binary morphology operations can be made.



10. Image analysis

An	alysis	Line profile	Extract color along a straight line
<u></u>	Line profile Histogram	Histogram	Calculate color histogram
3	Region extraction (only for BW) Particle color analysis	Region extraction (only for BW)	Extract regions in the binary image
1 ²³	Color quantification Pixel counter Average color value Multiple array analysis	Particle color analysis	Extract particles from a color image and calculate color values
***	Length measurement Custom coordinate Point location recorder	Color quantification	Count the number of pixels per color
_	Edge location measurement	Pixel counter	Count the number of pixels with a specified color
		Average color value	Count the average color value
		Multiple array analysis	Calculate color values at various locations with a grid-type ROI
		Length measurement	Calculate the distance between two locations
		Custom coordinate	Extract the location of the points in the chart image
		Point location recorder	Extract the location of the points by clicking on the image
		Edge location measurement	Extract the location of the points where the color changes rapidly

10.1. Line profile

After selecting a line on the shape toolbar, placing it on the image, and selecting the 'Line profile' menu, the user can check the color values of the pixels on the line graphically. When 'Box guided averaged value' is checked, a graph is drawn with the color average value of pixels located at right angles to a specific position of the line. Thickness is the length of the right angle line. After placing the mouse cursor on the graph and pressing the left button, the position in the image is displayed.



10.2. Histogram

The user can graph the color histogram of the image. Here, the histogram refers to the percent according to the color value. In the graph, the x-axis is a range of color values (for example, 0 on the left, 255 on the right), and the percent range on the y-axis (0 on the bottom and 100% on the top).



10.3. Region extraction (only for BW)

Region extraction is performed on the binary image to detect objects of white spots. The detected objects are colored in different colors and the calculated parameters are displayed in the table. When the user places the mouse cursor on the image and clicks the colored object, information about the selected object can be viewed in the table.

The 'Use Multiple ROIs for batch processing' option can be selected to perform image analysis on multiple ROIs in one image. The 'User screening condition' option can be checked to specify the minimum and maximum area and width of the objects to be detected and limit the number of the objects to be detected.

R	kan kee	se Multiple review se screeni a Min 10 a Max 50	ROIs for Labeling ng conditio	batch pro g □ Ce on Vidth(Hei Vidth(Hei	cessing enter poin ght) Min ght) Max	P Mult t Size	iple ROIs 5 □ Limit ma	x objects	Ж	C	ancel
XX	* Dog	uble click c	n Worksp Center X	oace wind Center Y	ow to find Width	l color Height	Color	X1	Y1	Cop X2	y table
	1	10773	382	302	164	769	F952E0	293	35	456	803
	1	10773 10334	382 87	302 457	164 174	769 658	F952E0 C28FEE	293 13	35 197	456 186	803 854
	1 2 3	10773 10334 7644	382 87 205	302 457 451	164 174 58	769 658 636	F952E0 C28FEE 2EAC5C	293 13 183	35 197 199	456 186 240	803 854 834
	1 2 3 4	10773 10334 7644 3	382 87 205 49	302 457 451 253	164 174 58 3	769 658 636 3	F952E0 C28FEE 2EAC5C CACDE9	293 13 183 48	35 197 199 252	456 186 240 50	803 854 834 254
	1 2 3 4 5	10773 10334 7644 3 12	382 87 205 49 565	302 457 451 253 286	164 174 58 3 3	769 658 636 3 5	F952E0 C28FEE 2EAC5C CACDE9 924DEF	293 13 183 48 564	35 197 199 252 284	456 186 240 50 566	803 854 834 254 288
	1 2 3 4 5 6	10773 10334 7644 3 12 7732	382 87 205 49 565 552	302 457 451 253 286 524	164 174 58 3 3 330	769 658 636 3 5 510	F952E0 C28FEE 2EAC5C CACDE9 924DEF C28925	293 13 183 48 564 466	35 197 199 252 284 345	456 186 240 50 566 795	803 854 834 254 288 854
	1 2 3 4 5 6 7	10773 10334 7644 3 12 7732 2	382 87 205 49 565 552 59	302 457 451 253 286 524 380	164 174 58 3 3 330 1	769 658 636 3 5 510 2	F952E0 C28FEE 2EAC5C CACDE9 924DEF C28925 F5F03D	293 13 183 48 564 466 59	35 197 199 252 284 345 379	456 186 240 50 566 795 59	803 854 834 254 288 854 380
	1 2 3 4 5 6 7 8	10773 10334 7644 3 12 7732 2 44	382 87 205 49 565 552 59 397	302 457 451 253 286 524 380 393	164 174 58 3 330 1 4	769 658 636 3 5 510 2 16	F952E0 C28FEE 2EAC5C CACDE9 924DEF C28925 F5F03D F604F7	293 13 183 48 564 466 59 396	35 197 199 252 284 345 379 385	456 186 240 50 566 795 59 399	803 854 834 254 288 854 380 400
	1 2 3 4 5 6 7 7 8 9	10773 10334 7644 3 12 7732 2 44 5	382 87 205 49 565 552 59 397 545	302 457 451 253 286 524 380 393 387	164 174 58 3 3 330 1 4 4	769 658 636 3 5 510 2 16 4	F952E0 C28FEE 2EAC5C CACDE9 924DEF C28925 F5F03D F604F7 B8D1E2	293 13 183 48 564 466 59 396 544	35 197 199 252 284 345 379 385 386	456 186 240 50 566 795 59 399 547	803 854 834 254 288 854 380 400 389
	1 2 3 4 5 6 7 7 8 9 9	10773 10334 7644 3 12 7732 2 44 5	382 87 205 49 565 552 59 397 545	302 457 451 253 286 524 380 393 387	164 174 58 3 3 330 1 4 4	769 658 636 3 5 510 2 16 4	F952E0 C28FEE 2EAC5C CACDE9 924DEF C28925 F5F03D F604F7 B8D1E2	293 13 183 48 564 466 59 396 544	35 197 199 252 284 345 379 385 386	456 186 240 50 566 795 59 399 547	803 854 834 254 288 854 380 400 389 ▼

Original image



Region extracted



10.4. Particle color analysis

Image particles (regions) can be detected automatically. In order to detect objects in a color image, several stages of image processing must be performed. However, this function integrates these tasks so that users can easily analyze images. In addition to being able to detect objects, the average color of red, green, or blue of individual objects is also extracted.

Workspace "Grains - Sunflower.jpg" [996x794] 100	0%		194 185	185	182 189 194 194 194 197 197	2 39 195 194	×
180 176 165 F	✓ Sh Partic ntens Numb	ow result I She le area 50 ity 0 er of particles 94	ow binary Color o - 2000 IV F - 255 Bas subt	Channel Red Particles are o eline 0 rraction	▼ dark	OK Re-analy Cance	уzө 91 ру
191 187	#	Red intensity	Pixel count	Mean X	Mean Y	Radius	•
	1	197.5	640	496.0	20.0	12.565	7
	2	190.0	459	794.0	67.0	15.898	
	3	179.0	635	209.0	75.0	8.156	_
199 198	4	192.2	653	173.0	120.0	7.421	
200	5	194.9	537	809.0	134.0	16.047	
7 198	6	187.9	582	460.0	130.0	12.101	_
	•						

Original image



Detected regions



10.5. Color quantification

Users can know the number of colors in the image. In the case of an image composed of a small number of colors, it is useful when determining the number of pixels per color.

Workspace "Green fluorescent leaf.jpg" [536x357] 200%									
	🛐 Coloi	r quantification							×
	# of col	lors 16 Multiple ROIs for b le click on Workspa	Datch pr	xclude b ocessing dow to fi	lack g 💾	Aultiple or	Analyzə ROls	🗎 Сору	
	#	Color code	Red	Green	Blue	Gray	Count	Percent	
	1	000000	0	0	0	0	151535	79.192	
	2	000040	0	0	64	7	4614	2.411	
	3	004000	0	64	0	38	19373	10.124	
	4	008000	0	128	0	75	12613	6.592	
	5	404040	64	64	64	64	1	0.001	
	6	00C000	0	192	0	113	2703	1.413	
The second se	7	004080	0	64	128	52	96	0.05	
	8	080000	0	0	128	15	236	0.123	
	9	00C040	0	192	64	120	40	0.021	
	10	008040	0	128	64	82	43	0.022	
	11	00C080	0	192	128	127	22	0.011	
	12	080800	0	128	128	90	7	0.004	-

10.6. Average color value

Users can use this function to compute the average color value of a specific area of the image.

(Fred	Average color value calculator	×
	Lab a ▼ Range: -90 ~ 90 (May be out of	-11.30542 range)
	Selection area (pixels)	11089
	Use Multiple ROIs for batch p	rocessing
	Predefined color formula	



10.7. Multiple array analysis

This is useful when analyzing the color for each well of a multi-well plate. After selecting a rectangular ROI, specify the number of horizontal and vertical wells, and then specify the shape and size of the cell to be analyzed. Then, press the 'Analyze' button to copy the analyzed result to the clipboard. The user can count the number of specific colors as well as the average color.



10.8. Length measurement

Since the distance between two points in the image is in pixel units, which is not the actual length, it is useful to convert the distance between two points from pixels to cm (or other units). The user needs to set the conversion factor to convert between units. Using the line shape, the user needs to place the line shape in an object (ruler for example) whose actual length is known. Then enter the actual length (cm) in the 'New length''.



Press the 'Start measure' button to fix the conversion factor between the length in pixels and the length in cm. Then, using the line shape to select any two points in the image, the distance between the two points is displayed in units of the length actually entered.

Setting Original length 727.00 Pixel New length 20 cm V Start measurement					nth leaves.jpg" [1200x984] 67%	Workspace "N bent
New length 20 cm Start measurement Result Length 8.306 cm	×	Pixel	ment 727.00 Pit	Length measurer Setting Original length		
Result Length 8.306 cm		cm	20 cn	New length		
Result Length 8.306 cm						
Length 8.306 cm	a 📗			Result		
			8.306 cm	Length		
	mataalaalaa	otenhantasilanteoleostasilas	nalantaalaataalaataalaataalaataala	a na hada a h	umhanalantanhanalantanhanadantanhanalanta	Indinduatenhadantan
25 25 25 25 25 22 22 23 24 25 25 27 3 24 25 25 25 25 27 3 24 25 25 25 25 25 25 25 25 25 25 25 25 25	8 29 1 ED	25 26 27 28 SESOURCES	20 21 22 23 24 25	: 13 14 15 16 17 18 19	4 5 6 7 8 9 10 11	0°* 1 2 3

10.9. Custom coordinate

The user can extract the position of points from chart images. The selection tool of the rectangle shape is positioned so that the x- and y-axes of the graph chart match. Then enter the minimum and maximum values for the x- and y-axes in 'X-axis' and 'Y-axis', respectively. The unit is entered for user convenience.



Then press the 'Start measurement' button. The coordinate then appears in the 'Result' panel when the mouse cursor is positioned at a specific position on the graph and then the left button is pressed. For other positions on the graph, click the mouse button to record the coordinates.



10.10. Point location recorder

This function is a continuous extraction of coordinates from specific locations in the picture. After positioning the mouse cursor in the image, click the left button to record the coordinates of the x- and y-axes.



11. Tool

		Bach	Performs multiple tasks of image
То	1	processing	processing sequentially
** @ @	Batch processing F4 Time lapse image capture Automatic image downloader	Time-lapse image capture	Take time-lapse images
8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	Online live view web service FTP image upload service Remote webcam server Remote webcam client	Dnline live view web service Automatic TP image upload service image Remote webcam server downloader	Download images from a specific IP address or web address
	Quick animation Online liv Create Video or Animated Gif file from images Online liv Batch Text Writer view web Extract frames from Video file service	Online live view web service	Provide camera video streaming to view real-time images on the web browser
		FTP image upload service	Upload images to FTP server regularly
		Remote webcam server	Build a webcam server so that other PCs can see the camera image on the server-side
		Remote webcam client	Connect to the webcam server and download the image
		Quick animation	Show animation from $2 \sim 5$ images and create an animated GIF file
		Create Video or Animated Gif from images	Create a video or animated GIF file from multiple images
		Batch Text Writer	Write text sequentially on multiple images
		Extract frames from Video file	Extract frame images from a video file

11.1. Batch processing

This function allows multiple image processing operations to be performed sequentially. This is especially useful when analyzing multiple time-lapse images. First, set 'Source', which includes images. In the 'Output' option, the user can set whether to save the image analysis results to the clipboard or record them as text files. If the user executes the 'Save image' command to save the currently processed image, set the folder in the 'Destination folder for 'Save image' command. Delay in 'Option' refers to the delay between each image processing.

Workspace "2011-10-04 (11-00-00)jpg" [640x465] 100%	Step 1: Config Step 2: Edit Step 3: Run Source 3. Current folder in File Meneger window Show	File Manage:	Cr 🔀
	Output Image: Set Clipboard Image: Set Text file D: \My Tools \MPhenoCapture \MUnitIted .csv Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image: Destination folder for 'Save image' command Image: Set Image:	File name Size 2011-10-04 (08-30-00).jpg 1 2011-10-04 (09-30-00).jpg 1 2011-10-04 (09-30-00).jpg 1 2011-10-04 (10-30-00).jpg 1 2011-10-04 (10-30-00).jpg 1 2011-10-04 (11-30-00).jpg 1 2011-10-04 (12-30-00).jpg 1 2011-10-04 (12-30-00).jpg 1 2011-10-04 (12-30-00).jpg 1 2011-10-04 (13-30-00).jpg 1 2011-10-04 (13-30-00).jpg 1 2011-10-04 (14-30-00).jpg 1 2011-10-04 (14-50-00).jpg 1 2011-10-04 (15-50-000).jpg 1 2011-10-04 (15-50-000).jpg 1	(kb) ^ 41.3 40.9 39.5 41.6 40.5 40.6 41.3 39.6 40.0 41.7 42.0 41.7 42.3 41.5 × Refresh

Next, the user has to enter image processing commands in the 'Step 2: Edit' tab. Click the 'New' button to set the Preset name. Then, select the command to be executed sequentially in the 'Unit module' list, then click the 'Add' button or double-click the left mouse button. To use the configured preset again, save it by pressing the 'Save Preset" button. When the user clicks the 'Step 3: Run' tab and then presses the 'Start' button, image analysis proceeds. In this example, '# Average color value' is included. After calculating the average color value from individual images, the result is saved in the clipboard.

create r	new preset! 🛃 Save Preset
•	🖺 New 🦉 Rename 💌 Delete
	Process
^	Gray scaling
	Invert
	Adaptive binarization
	# Average gray value

atch processing		
ep 1: Config Step 2: Edit Step 3: Run		
# Average gray value	^	▶ Start
2011-09-29 (20-30-00).jpg loaded Gray scaling Invert		II Resume
Adaptive binarization # Average gray value		Stop
2011-09-29 (21-00-00).jpg loaded Gray scaling Invert Adaptive binarization # Average gray value		
2011-09-29 (21-30-00).jpg loaded Gray scaling Invert		
Adaptive binarization	~	
Do not update		5/420

11.2. Time-lapse image capture

'Time-lapse capture capture' is available from the 'Tool' menu. The imaging source can be specified in the 'Image source' option.

mage source Camera ● Local webcam ○ Image URL Set 5 ▼	Error Check Stop imaging when Max identical images	Þ	Start
○ Screen			Stop
Time interval	d ophedule		Save now
 Every second Every minute Every hour 00:00:00-24: 04:00:00-04: 10:00:00-10: 16:00:00-10: 16:00:00-16: 22:00:00-22: 00:00:00-24: 04:00:00-04: 10:00:00-10: 16:00:00-10: 16:00:00-10: 16:00:00-22: Every hour I I Every hour I I I I I I I I I I I I <lii< li=""> <lii< li=""> I<td>00:00(00:01:00) 30:00(00:00:01) 30:00(00:00:01) 30:00(00:00:01) 30:00(00:00:01)</td><td>5</td><td>Open Log</td></lii<></lii<>	00:00(00:01:00) 30:00(00:00:01) 30:00(00:00:01) 30:00(00:00:01) 30:00(00:00:01)	5	Open Log
Continuous capture	Camera Erro	r Email	Notification
Save Image file format JPG Image quality 95	Email ID Password	temp(@gmail.com
✓ Default data folder Image: Set D:₩My Tools₩PhenoCapture₩data	Port number	465 ≢⊠	Test
, Print time stamp			

The user can select from the currently connected camera, Internet URL address, or current monitor screen. The 'Camera Error Check' option can set the termination condition when the camera is disconnected and the image is not captured normally. In the 'Time interval' option, the user can specify the time interval to capture, and check the 'User defined schedule' to program the imaging time in various ways. The time format of 'User defined schedule' is hh: mm: ss-hh: mm: ss (hh: mm: ss), indicating the start time-end time (imaging interval). When

multiple lines are entered, the lower the priority, the higher the priority. In the 'Save' option, the user can specify the format of the image file and the destination folder to be saved. If the user checks the 'Camera Error Email Notification' option, a warning email can be sent to a specified email address when camera errors occur. Time-lapse capture can be initiated by pressing the 'Start' button and finishing by pressing the 'Stop' button.

11.3. Automatic image downloader

The user can download images from a specific IP address or web address. This function can be linked with the time-lapse image capture function. When the user selects 'Image URL' as 'Image source' in the time-lapse capture function, images can be downloaded and saved at regular time intervals.

Automatic Image Downloader	×
Image URL http://192.168.0.32/test.jpg	
Abort after (sec) 10 💽 🕨 Download now	
Status	

11.4. Online live view web service

- This function provides camera video streaming to view real-time images on the web browser. This is useful for viewing camera images connected to a remote PC through a mobile device. In order to view the webcam image on an external device, the user must set the router's 'port forwarding' to access it externally.

Online live view web service ×				
IP address 192.168.0.2	Port numbe 80			
Auto file naming 7c3fad53d453721clYlll				
Webcam name myPC	▶ Start ■ Stop			
Image format JPG Quality 90 * Webpage should be refreshed when changed				
Website address	Launch web browser			
http://192.168.0.2/7c3fad53d453721clYlllK9sfo.html				
Website address (external IP address)				
http:// :3fad53d453721clYlllK9sfo.html				
Port forwarding needed if you use a router!				

The following figure is a scene of checking the video by accessing the IP address with a web browser.



11.5. FTP image upload service

The user can upload images to the FTP server regularly. Both FTP and SFTP (secured FTP) modes are supported. If the 'Start' button is pressed while the camera is connected, the image upload starts. Click the 'Create Image Viewer (HTML)' button to create an HTML file to check the uploaded image on the FTP server. The user can upload this file to the FTP server and see the image being updated at regular time intervals. For privacy, if 'Blank image when motion detected' is checked, a blank image can be uploaded instead of the original camera image if an object appears.

	r (HTML)
mage source Webcam 💌	Update interval 2 Sec
File name espcamview jpg	▼ Quality 90 ▼
Destination	
FTP server Local disk	
FTP address phenocapture.com	_
User ID phenocapture	Port # 21
Password *********	Folder user2018/monitor
Image capture status 🔽 Time stamp	Blank image when motion detec
Current Movement Hits (%)	
Tolerance	20
Threshold of Movement Hits (%)	20
	3
Number of skips when motion detected	

11.6. Remote webcam server

The user can build a webcam server. After making the PC to which the camera is connected as a remote webcam server, the user can download images by connecting to the server PC from another PC. Images can be simultaneously downloaded from multiple PCs connected to one webcam server. After setting any 'Port number', 'User ID', and 'Password' that can be accessed, press the 'Start' button to start the server operation.



11.7. Remote webcam client

The user can connect to the webcam server and download the image. After setting the 'Port number', 'User ID', and 'Password' that can access the server, click the 'Connect' button to start downloading the image. This function can be linked with the time-lapse image capture function. When the user selects 'Remote webcam' as 'Image source' in the time-lapse capture function, images can be downloaded and saved at regular time intervals.



11.8. Quick animation

This function is to show animation from $2 \sim 5$ images and create an animated GIF file. This is useful when the user needs to observe the difference between the two images. If the 'Import two recent images automatically' option is selected, the latest working images are automatically loaded.



11.9. Create Video or Animated GIF file from images

The user can create a video or animated GIF file from multiple images. Depending on the type of compressed codec installed on the PC, the user can save as a variety of video files and as animated GIF files. When the 'Crop rectangle out of image' is checked, only a specific area of images can be saved as a video through the rectangle selection tool. When the 'Record' button is pressed, the video creation starts. When saving as a video file, a compression codec and a window for various settings appear first.

號 Video Encoder
Source 2. Current folder in File Manager window
Destination D:₩My Tools₩PhenoCapture₩Output1.avi
Option Format Video Geodetication Format Video Frame rate 10 Frame rate
Show text (C) PhenoCapture Location (Y) 5 Fore color Border color
0/0 Record Stop

11.10. Batch text writer

The user can write text sequentially on multiple images. In the 'Source' option, specify the folder where multiple images are stored, and in the 'Output' panel, specify the image format, text font, and folder of the image file to be saved. Enter the coordinates and color of text output in the 'Caption option' panel. Text to be output for each image is entered in the text box below it. The format of the text to be input is F#: text, where # specifies the number of images to be displayed in the number.

Batch Text Writer	×
Source	
2. Current folder in File Manager window	Show
Output	
Image file format JPG	-
Destination folder	
D:₩My Tools₩PhenoCapture₩data	Set
Caption option	1
Location X 2 Y 2 Fore color Border color F	ont
Tip: F means the frame number. Caption is written in the right side of ':' mark	
F1:Location at 0 um F2:Location at 20 um	^
F3:Location at 40 um	
F5:Location at 80 um	
	~
0/0	
Percent Stor	

11.11. Extract frames from Video file

The user can extract frame images from a video file. Specify the time to start and end the extraction in 'Range' and the time interval to extract in 'Interval'. When the 'Extract' is clicked, the currently viewed scene is saved as an image, and when the 'Extract all' button is pressed, the images are sequentially extracted from the time range set in 'Range' and saved as image files.

I Frame Extractor	"Onion animation.avi" 100%	×
	AN A	
	- J	00:14
▶ <u>■</u> 00:03	Image Image <t< td=""><td></td></t<>	
G D Interval	5 Second V Mute	
Extract	Extract all File name Frame JPG	
Copy frame	Destination):₩My Tools₩PhenoCapture₩Sample	