# IMAGE MEASUREMENT

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# Description of the Form Controls

## Error Analysis on the form menu

"Check Error" allows the user to test how well they are able to select measurements at various zoom factors. The leftmost crosshairs should be selected first.

## Image on the form menu

"Cursor"  This item allows selection of a crosshair cursor or the default cursor when positioned over the image.

"Goto Image"  This item allows you to go to any existing image in the Database. You can skip forward or backward to an image.

"PreLoad the Next Image" ..If set to "On", the next image will be preloaded while you work on the current image.

"Scale Calculator"  This item opens up a scale calculator for calculating the scale based on the camera parameters and the distance from the object being measured. See the Help Page on "Image Resolution Calculation".

Select Database  This allows the selection of the Excel Spreadsheet which contains the database of images to be measured. A Database must be opened before any measurements can be done.

## Help on the form menu

Contents opens this help file.

Download Acrobat Reader goes to the web site to download the reader which is used to read the Help Files.

About opens the about Message Box.

# Next Image button

Moves to the image in the Database.

# Save button

Saves the LAST set of measurements taken with the mouse button clicks. The results are inserted into the corresponding fields in the Database in the record associated with the current KEY.

# Grid button

This places red lines (as cross hairs, vertical lines, or horizontal lines) across the image to aid in selection of the proper region for measurement. Your application may not use these.

# Clr Grid button

This clears the red grid lines.

# Clr All Meas button

This clears all the measurements made on this image and reloads a clean copy of the image.

# Clr Last Meas/Cancel Area button

This clears the last measurement made OR if in the middle of an area measurement, it cancels the area measurement process without clearing any measurements.

# Add Space button

This adds a blank measurement into the database.

# Point 1 ---- Point 2 labels

X1, Y1 are the mouse coordinates of the first mouse button click on the image.  X2, Y2 are the coordinates of the second "click".

# Distance label

This is the calculated distance from the first mouse click to the second mouse click multiplied by the SCALE factor from the database and the appropriate zoom factor.  It is in the same units as the SCALE factor.  (i.e. If it is in cm/pixel, then the displayed units are in cm.)

# Zoom

The various radio buttons are used to select the zoom factor.  Zooming is done by right clicking in the area to be zoomed.

# Resize button

This button reloads the original unzoomed image.  An alternative to using this button, is to right click on the zoomed image.

# Linear and Area radio buttons

These buttons select the mode of measurement, either linear or area measurement.

# No Meas Field

This allows the user to select whether a single measurement or multiple measurements are being made on a particular image.  The maximum number of measurements that can be made on a single image is ten.

# KEY label

This displays the KEY of the image currently being shown.

# <u>Current Image</u> label

**This displays the path of the current image.**

# <u>Meas Made</u> label

**This label indicates how many (if multiple measurements are being made) measurements have been made on the current image.**

# <u>Area Shown</u> labels

**These labels indicate the size of the area being viewed on the image.**

# <u>Scale</u> label

**The scale in 'units' of each pixel.**

## Add Space Button

**This adds a zero in the list of measurements made.  This may be used to separate measurements when multiple segments are used in a single measurement.**

# <u>Exit</u> button

**As expected, this exits the application.**

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# Description of the Image Measurement Program

The image measurement program was written initially to be used for the measurement of stream widths based on aerial images.  It was somewhat generalized to be used for measurement of distances on any "calibrated" image (one whose distance/pixel is known) and to allow multiple measurements per image.

Image Measurements is written in C# which is currently the newest programming language from Microsoft® Corporation in its Visual Studio.NET suite.  C# is an object oriented language with significant graphics support.  The programming paradigm for creating windows programs (forms/screens) is the very best and easiest to use that the author has ever seen.  It allows powerful easy rapid prototyping to be done.

A database provides for the user to input what series of images are to be measured.  It also provides storage for the record of the values of the measurements.  An Excel Spreadsheet was chosen as the database because most people are familiar with Excel and can more easily use it to input the required data fields and to manipulate the output data.  The data collected can easily be copied to any other Excel Spreadsheet for further analysis or storage.  The database contains input from the user of the name of each image and its scale.  The program provides output to the database in terms of what was measured (i.e. the measured distances and their zoom factor and internal scale).  Up to 50 measurements can be made on each image.

The program loads each image into a 'picturebox' which is a C# control. The image is 'resized' to fit in the picturebox. For example, an image may be 4064X2704 pixels with a scale of 1.55 cm/pixel. The picturebox is sized at 924X614 pixels which is roughly the same aspect ratio (4064/2704 = 1.50). So the image is reduced to fit into the smaller box and the scale is changed accordingly (i.e. the scale now is 6.817 cm/pixel). As the user selects a measurement to make and left clicks on the image, the X,Y mouse coordinates are recorded. After the second click, the distance is calculated as the scale factor times the square root of $(X1-X2)^2 + (Y1-Y2)^2$. This data is then recorded in the database when the user clicks on 'Save'. Images with a different aspect ratio cause the picturebox to be rescaled to the same aspect ratio as the image.

The program provides several 'zoom factors' (2X, 4X, 8X, and 16X). Whenever the user zooms (by right clicking on the desired area), the original image (not the resized image as described above) is used to create the new zoom field. Note that the accuracy of any measurement is improved by zooming because the user can see in more detail the area to measure; more accurately select the measurement; and the scale factor is reduced. In the above example, the 1X scale factor is 6.817 cm/pixel. At a 16X zoom, the new scale factor is 0.426 cm/pixel. So if the measurement error is off by one pixel, in the first case the error would be 6.817 cm, where as in the second case it would be 0.426 cm (an improvement of 16X).

The program allows the user to make a single or multiple measurements on an image. When a single measurement is selected, the user can make multiple attempts to get the exact measurement desired, and then only the last measurement is recorded. When making multiple measurements, the measurements are all stored internally until the user saves them. Then they are all recorded. In either case, the internal

**measurements can all be cleared by clicking on 'Clear Lines'. Note that a total of fifty measurements can be made on each image.**

# Excel Database Integrity Checks

Several checks are performed by the program to protect against user error in the Excel Database which might result in erroneous measurement data being inserted into the database.  These checks should prevent that.   See the Help Page on Setting up the Excel Database.

1.   If the database does not conform to the instructions for setting up the Excel Database, the program shows a Message Box with the message

```
"This is a badly formed database!!!
  See the help for setting up the database"
```

If this occurs, FIX the Excel Database then proceed.

2.   When the Excel Database is first selected, the program insures that the KEY numbering is sequential.  If not, the program shows a Message Box with the message:

```
 "Bad KEY sequence starting at KEY = "
```

This indicates that the user needs to renumber the KEY field in the database.

The program also indicates the number of images found which is shown in a Message Box.  If this is less than you expected, then perhaps a KEY is missing in the Excel Database.

3.   When each image is loaded, it checks to make sure that the Database contains an image name in the field called "IMAGE".  If not, the program shows the following message:

```
"Image is missing from KEY = "
```

The KEY is given, so it is easy to find and insert the filename of the

**missing Image.**

**4.   If the SCALE is missing for the Database, the program shows:**
`"Scale is missing from KEY = "`
**The KEY is given, so it is easy to find and insert the missing scale constant.**

**5.   If the image type is not of the allowable image types, the program gives:**
`"Wrong image type or missing image from KEY = "`
`Allowed image types are bitmap, JPEG, TIF, GIF or PNG"`
**If this occurs, then you need to use your "batch processing" feature of your image processing program to change to a JPEG or related type.**

# How to Use Image Measurement

1.   Make sure the screen size is set to 1024 X 768 Pixels.  The program is calibrated for this size.  Other screen sizes need a little different calibration for the Y pixel measurements.  If you use the program with a different screen size, your measurements may be invalid.

2.   Set up the Excel Database (see the Help page on setting it up).  Store the Database and the images in the same directory.

3.   Start the Image Measurement Program.

4.   Select the Excel Database.

5.   Select the first point to measure.  Click once.  This leaves a small yellow circle to mark the spot.  The X,Y coordinates of the fist click appear in the label called Point 1.  Select the second point to measure.  Click once.  This also leaves a small yellow circle plus a straight line between the two points.  The X,Y coordinates of the second click appear in the label called Point 2.  The distance in Units appears in the label called Distance.  The units are the same as the SCALE in the Database.  (I.e. if SCALE is 1.5 cm/pixel, then Unit is cm.)

6.   If you are satisfied with this selection, Click on the Save button to insert the results into the database.  Otherwise, clear the lines and measure again as per step 5.

7.   Click on "Next Image" to bring up the next image and go

**back to step 5.**

**Database Notes:**

**Note that when making single measurements, the newly measured data is stored in the first entry (DISTANCE1) for that image.  If there is already data in that field it is overwritten with the new data.  When making multiple measurements, the first ten measurements are written to the ten DISTANCE fields.  They too are overwritten, if they already contain data.  Also, suppose the record contains 8 previous measurements, then you make 3 more.  The first 3 are overwritten and the last 5 are unchanged.  So you need to manage your own data.**

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# Calculating Image Resolution

**Image resolution is defined by how much actual area is represented by each image pixel.**

**To calculate image resolution, the following information is required:**

**1. Lens focal length** *(F)*

**2. Camera distance from object** *(D)*

**3. Digital camera sensor dimensions (W x H)** *(CW, CH)*

**4. Final image pixel dimensions (W x H)** *(PW, PH)*

**Step 1. Convert *F, D, CW* and *CH* to like units.**

**Step 2. Calculate *IW=(D\*CW)/F* where *IW*= Width of image coverage.**

**Step 3. Calculate *RW=IW/PW* where *RW*= horizontal image resolution**

**Step 4. Calculate *IH=(D\*CH)/F* where *IH*= Width of image coverage.**

**Step 5. Calculate *RH=IH/PH* where *RH*= horizontal image resolution.**

**Step 6. Compare *RH* to *RW* to ensure equality. If they are not equal, then your image pixels are not square, and will require a constant correction to achieve accurate measurement.**

**Example: Canon 1DS Digital Camera**

*F*=**300 mm**

*D*=**100 m**

*CW*=**35.8 mm**

*CH*=**23.8 mm**

*PW*=**4064 pixels**

*PH*=**2704 pixels**

**Step 1. Convert *F, D, CW* and *CH* to like units.**
*F*=300mm=0.3m
*D*=100m
*CW*=35.8 mm=0.0358m
*CH*=23.8 mm=0.0238m

**Step 2. Calculate *IW=(D\*CW)/F* where *IW*= Width of image coverage.**
*IW*=(100m\*0.0358m)/0.3m = 11.93m

**Step 3. Calculate *RW=IW/PW* where *RW*= horizontal image resolution**
*RW*=11.93m/4064pixels = 0.00293m/pixel

**Step 4. Calculate *IH=(D\*CH)/F* where *IH*= Width of image coverage.**
*IH*=(100m\*0.0238m)/0.3m = 7.93m

**Step 5. Calculate *RH=IH/PH* where *RH*= horizontal image resolution.**
*RH*=(7.93m/2704pixels = 0.00293m/pixel

**Step 6. Compare *RH* to *RW* to ensure equality.**
*RW* = 0.00293m/pixel = *RH* = 0.00293m/pixel
**Since *RW=RH*, images taken with this camaera can be measured with no correction constant.**

**A simple scale calculator is provided in the menu item IMAGE| SCALE CALCULATOR.**

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# Performance Discussion

**If You Are Having Performance Problems Consider**

**1. Processor speed may be a factor since the images may be resized when loading on the form. On a 2.0 GH class machine with images of about 3 MB, images load in about 3 seconds. The only suggestion is to stop any other applications that may be running.**

**2. Image size may be a factor; very large images will load slower.**

**3. If you have the directory containing the images and Excel database somewhere on your network, the speed will be affected greatly by the speed of your network. Optimal performance, of course, will be possible if you have all the files on your local disk.**

**The program should be relatively insensitive to the number of images being measured.**

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# Setting Up the Excel Database

A simulated Excel Database for this program is show below, as an example:

| | A | B | C | D | E | | N | O | P |
|---|---|---|---|---|---|---|---|---|---|
| 1 | KEY | IMAGE | SCALE | DISTANCE1 | COMMENT | DISTANCE2 | D...50 | ZOOM1 | K1 |
| 2 | 1.00 | Stream1.jpg | 1.55 | 83.8500 | Notes image | 123.76 | | 4 | 1.7080 |
| 3 | 2.00 | Stream2.jpg | 1.40 | 1429.3143 | notes | | | 1 | 6.5236 |
| 4 | 3.00 | BIGOWL.bmp | 1.55 | 1786.8393 | notes | | | 8 | 0.8535 |
| 5 | 4.00 | Sunflower.jpg | 1.50 | 2345.5933 | | | | 1 | 6.61171 |
| 6 | 5.00 | Fawn.tif | 1.53 | | | | | | |
| 7 | 6.00 | | | | | | | | |
| 8 | 7.00 | | | | | | | | |
| 9 | 8.00 | | | | | | | | |

Note: The database extends to include data for fifty DISTANCE'S, fifty ZOOM'S, and fifty K'S.

This Excel database contains data for four of the entries.

<u>KEY</u> is a field that must be numbered sequentially from 1 to the maximum number of images being measured.  KEY is used as a database key to reference items in the database.  The KEY values should be integers.

<u>IMAGE</u> is a field that contains the file name of the image to be measured.  Allowable image types are bitmap, JPEG, GIF, TIF and PNG.  Image names listed in the database, must include the file extension.

<u>SCALE</u> is a field that contains the scale factor for the image.  It should

be as units/pixel.  For example, the first image above, stream1.jpeg, has a scale of 1.55 cm/pixel.

**<u>DISTANCE1</u> to DISTANCE50** is the computed distance between the points (x1,y1) and (x2,y2) multiplied by the scale factor K (see below).  It is calculated and entered into the database as measurements are made.  In the example above, for the first entry, the DISTANCE1 is 83.85 cm.  The units in this cell are the same units as in the SCALE cell.  Note that there are 10 DISTANCE fields, one for each possible measurement.

**<u>ZOOM1</u> to ZOOM50** is the zoom factor that was used for the particular measurement.

**<u>K1</u> to K50** is the scale factor based on the resized image; the image scale; and the ZOOM.  This also is recorded for each measurement.

# NOTE: all the images AND the Excel database MUST be in the same directory.

## Create the Database

1.  Open Excel and select columns D though EX.  Format the columns as numbers with however many digits of precision that you want to see.  The example has four.
2.  Select columns A through EX in order to name (or define a range in the database).  The following instructions are for Excel 2000, other versions may differ in the details. Use the Excel menu steps as INSERT|NAME|DEFINE.  Enter the name DATA in the top textbox.  The textbox at the bottom, called 'refers to', should contain =Sheet1!$A:$AG.  Click on ADD.  This names the entire set of columns A-AG as DATA which is where all the image information and measurements reside.

**3.   As shown in the example above, enter KEY into A1, IMAGE into B1, SCALE into C1, DISTANCE1 into D1… Do this for all the required fields.  You should fill the spreadsheet through EX.**

**4.   Save the Excel database in the same directory with all the images.**

**5.   If you don't follow these instructions exactly, you will probably get an error that says "Badly formed database!" when you try to make measurements.  The software makes a number of integrity checks to insure the database information is valid.**

## Alternative to Creating the Database

**Copy the Sample database and use it!**

## Enter the Data

**1.   Enter the Image names into each field called IMAGE.  See the page on "Using the DOS Command Prompt to generate filename lists".  In the cell next to each image, enter the appropriate scale factor, similar to shown above.  See the help page on determining Image Resolution.**

**2.   Create a set of keys for the database in the field called KEY. Start with 1 and number them sequentially in increasing order.**

## Install the Excel Database

**1.   Put the Excel database into the same directory with all the images.**

## Proceed to measure

**1.   See the help page on How to Use the Image Measurement Program.**

**NOTE: A Sample database is included with the installation. As an alternative to the above, just make a copy of the sample and insert your own data.**

## Database Notes:

**Note that when making single measurements, the newly measured data is stored in the first entry (DISTANCE1) for that image. If there is already data in that field it is overwritten with the new data. When making multiple measurements, the first ten measurements are written to the ten DISTANCE fields. They too are overwritten, if they already contain data. Also, suppose the record contains 8 previous measurements, then you make 3 more. The first 3 are overwritten and the last 5 are unchanged.**

**So you need to manage your own data.**

## NOTE: Regarding Images

**It has been assumed that the images are in "landscape mode", that is the image is, say 4064 pixels WIDE and 2704 pixels HIGH. If this is not the case, the images will be rotated automatically 90 degrees right. It is also assumed that the images are in the aspect ratio as per the first sentence. If not, the picturebox will be rescaled so that the entire picture is viewable. This will leave empty area in either the bottom or right side of the form.**

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# Using the DOS Command Prompt
## to Generate Filename Lists

The DOS Command Prompt found at START|PROGRAMS|ACCESSORIES can create a list of image names for pasting into the database to save the time of manually typing in the filenames. In the DOS terminology, the following commands are helpful:

| | |
|---|---|
| e: | sets the E: drive as the root |
| cd \ | change directory to the root directory |
| cd directory | type this in prior to the name of a directory you want to go to. |
| dir | provides a raw listing of all files in the current directory |
| dir /b | provides a basic listing of all files in the current directory, filenames only |
| dir /b *.jpg | provides a basic listing of all jpg files in the current directory, filenames only.   Any filename type can be listed in this way, such as *.tif, *.bmp. |
| Help dir | lists dir command options. |
| dir /b>text.txt | creates a text file listing the filenames of all files in the directory. This can be used in conjunction with the *.jpg command, for example, to create a text list of all the jpg files in a directory. |
| | |

## EXAMPLE:

**You want to create a text filename list of three images located at E:\Images\Test_Folder\July\. Type the following (red) after the black DOS readouts (actions are described in green text):**


**C:\Documents and Settings\Administrator>e:** *(changes to E drive)*

**E:\>cd Images\Test_Folder\July** *(goes to the correct directory)*

**E:\Images\Test_Folder\July>dir /b** *(lists file names only)*
**july01.jpg**
**july02.jpg**
**july03.jpg**


**E:\Images\Test_Folder\July>dir /b *.jpg>julyimages.txt** *(creates txt file)*

**E:\Images\Test_Folder\July>dir /b** *(checking for txt file creation)*
**july01.jpg**
**july02.jpg**
**july03.jpg**
**julyimages.txt** *(new text file is present))*

**There are two ways to finish: (either will work)**
> **1. Open Microsoft Excel. Click FILE|OPEN and select "Text Files" in the "Files of Type:" pull-down menu. Open julyimages.txt. The Text Import Wizard will open. If you created a basic listing as shown in the example, click FINISH right away since there is no need to specify delimitation for a single column of information. If the text file was made of a raw listing (no /b in the command line), then you will have to go through the Text Import Wizard's three steps and specify SPACE as the delimiter. Once the file is open, copy and paste the filename column into the ImageMeasurement IMAGE column.**

**2.   On the DOS command line type "notepad julyimages.txt".  This opens up the new file into a window.  Type a "Ctrl A" which selects all the images in the list, then type a "Ctrl C" to copy this to the clipboard.  Open the Excel Spreadsheet, position the cursor to the first location for images, and type "Ctrl V".  This pastes the result into the image column.**