MID-ATLANTIC MEGALOPOLIS PROJECT

Funded by the Advancing Digitization of Biodiversity Collections program of the National Science Foundation.
LIGHT BOX DESIGN: A CAUTIONARY TALE

https://www.idigbio.org/content/how-and-how-not-design-light-box-cautionary-tale

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FINE FOCUS:
A tool for the objective evaluation of focus quality in herbarium specimen imaging

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“SOFT” FOCUS ISSUES

- collaborators reporting soft focus issues
  - random specimens not quite in focus(1:1), seen in image processing
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- began investigation of focus quality
  - objective numeric value for focus quality → contrast value as a proxy
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Standard Deviation of Contrast Values

![Graph showing standard deviation of contrast values with data points at 6, 7, 8, 9, 10, 11, 12, 13]
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Standard Deviation of Contrast Values

Focus
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![Standard Deviation of Contrast Values]

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Standard Deviation of Contrast Values

Focus  Focus  Focus
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values are specimen- and condition-dependent $\rightarrow$ only comparable for images of a single sheet taken with identical settings (e.g., aperture, lighting, placement of sheet)
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values are specimen- and condition-dependent → only comparable for images of a single sheet taken with identical settings (e.g., aperture, lighting, placement of sheet)
  → repeated imaging needed to understand focus quality possibilities for any one specimen
20-SPECIMEN TEST CASE

- 20 specimens, all “2-D” but with variation in material
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- 20 specimens, all “2-D” but with variation in material
- repeated imaging (20-50x) of single sheets
- Canon 5DS DSLR (50 mp) using AUTOFOCUS
20-SPECIMEN TEST CASE

- 20 specimens, all “2-D” but with variation in material
- repeated imaging (20-50x) of single sheets
- Canon 5DS DSLR (50 mp) using AUTOFOCUS
- camera settings held constant (1/100, f9, ISO100, picture auto-settings off)
- white-balanced to color checker by batch
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- repeated imaging (20-50x) of single sheets
- Canon 5DS DSLR (50 mp) using AUTOFOCUS
- camera settings held constant (1/100, f9, ISO100, picture auto-settings off)
- white-balanced to color checker by batch
- treatments:
  - Live View vs. no Live View
  - macro 50 mm lens (Canon, Sigma) vs. standard 50 mm lens (Canon)
20-specimen test case

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- Canon 5DS DSLR (50 mp) using AUTOFOCUS
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- treatments:
  - Live View vs. no Live View
  - macro 50 mm lens (Canon, Sigma) vs. standard 50 mm lens (Canon)
- varied treatment by specimen – to allow for single placement of sheet
20-SPECIMEN TEST CASE

The diagram shows the standard deviation of contrast values for different specimen numbers and viewing conditions:

- **MACRO_LIVE_VIEW**
- **MACRO_no_LIVE_VIEW**
- **STANDARD_LIVE_VIEW**
- **STANDARD_no_LIVE_VIEW**

Each point represents a specimen, with the x-axis showing the standard deviation of contrast values and the y-axis showing the specimen number.
20-SPECIMEN TEST CASE

"soft" focus difference

specimen number

standard deviation of contrast values

MACRO_LIVE_VIEW  MACRO_no_LIVE_VIEW  STANDARD_LIVE_VIEW  STANDARD_no_LIVE_VIEW
20-SPECIMEN TEST CASE

MACRO_LIVE_VIEW
MACRO_no_LIVE_VIEW
STANDARD_LIVE_VIEW
STANDARD_no_LIVE_VIEW

standard deviation of contrast values

specimen number

“soft” focus difference

obvious focus difference
• $$$, need better output than Canon autofocus achieves
IMAGE QUALITY MATTERS

- $\$, need better output than Canon autofocus achieves
- downstream effects of focus issues not fully known
IMAGE QUALITY MATTERS

- $$, need better output than Canon autofocus achieves
- downstream effects of focus issues not fully known
- need more consistent focus quality from same equipment that will work with batch imaging (100-200 sheets/batch)
FINE FOCUS

- use standard text target and numeric value to manually focus lens to optimal focus quality
FINE FOCUS

- use standard text target and numeric value to manually focus lens to optimal focus quality
- numeric value (st. dev. contrast value) generated through image analysis via batch file, using IrfanView and ImageJ
- use standard text target and numeric value to manually focus lens to optimal focus quality
- numeric value (st. dev. contrast value) generated through image analysis via batch file, using IrfanView and ImageJ
**FINE FOCUS**

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- Use standard text target and numeric value to manually focus lens to optimal focus quality.
- Numeric value (st. dev. contrast value) generated through image analysis via batch file, using IrfanView and ImageJ.
- “Lock in” good focal point by switching lens back to autofocus (drift).
- Image a batch of specimens without changing focal point.
20-SPECIMEN TEST CASE + FINE FOCUS

specimen number

standard deviation of contrast values

MACRO_LIVE_VIEW  MACRO_no_LIVE_VIEW  STANDARD_LIVE_VIEW  STANDARD_no_LIVE_VIEW  MACRO_FINE_FOCUS  STANDARD_FINE_FOCUS
20-SPECIMEN TEST CASE + FINE FOCUS

MACRO_LIVE_VIEW  MACRO_no_LIVE_VIEW  STANDARD_LIVE_VIEW  STANDARD_no_LIVE_VIEW  MACRO_FINE_FOCUS  STANDARD_FINE_FOCUS

only get out of Fine Focus what you put in
is this only a Canon problem?
20-SPECIMEN TEST CASE: NIKON

- 20 specimens, all “2-D” but with variation in material
- repeated imaging (20-50x) of single sheets
- Nikon D850 DSLR (46 mp), standard 50 mm lens (Nikkor)
- camera settings held constant (1/100, f9, ISO100, picture auto-settings off)
- white-balanced to color checker by batch
- treatments:
  - Live View (two focal options) vs. no Live View
- varied treatment by specimen – to allow for single placement of sheet
20-SPECIMEN TEST CASE: NIKON

Specimen number

STANDARD_LIVE_VIEW_normal
STANDARD_LIVE_VIEW_wide_area
STANDARD_no_LIVE_VIEW_group

live view better than no live view (sensor)
20-SPECIMEN TEST CASE: NIKON

how to compare cameras?
20-SPECIMEN TEST CASE: NIKON

how to compare cameras?
range = (max – min) per txt
how to compare cameras?
range = (max – min) per txt
0 = “good” focal quality
RANGE OF FOCAL QUALITY: CANON VS. NIKON

- Range (max - min) of st-dev of contrast values per specimen

Chart showing the comparison between Canon and Nikon in terms of range of focal quality.
RANGE OF FOCAL QUALITY: CANON VS. NIKON

autofocus capabilities in Nikon have much tighter range of focal quality than in Canon.
Summary

- Canon autofocus “wanders” off of optimal focal quality
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  - provides objective (but relative!) measure of focal quality
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- Nikon autofocus better in Live View than without Live View
SUMMARY

- Canon autofocus “wanders” off of optimal focal quality
- Fine Focus procedure
  - provides objective (but relative!) measure of focal quality
  - can narrow focal quality to upper end of range (when done correctly!)
- Nikon autofocus better in Live View than without Live View
- Nikon autofocus has tighter range around optimal focal quality than Canon
FOR MORE INFO...

- cskema@upenn.edu
- mamdigitization.org – project website & FineFocus download

**MID-ATLANTIC MEGALOPOLIS**

*The Project*

Achieving a greater scientific understanding of our urban areas, one plant specimen at a time.
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A VIDEO DEMONSTRATION – by Michelle Mancini & Cindy Skema
F-STOP & FOCAL QUALITY

The graph shows the range (max - min) of standard deviation of contrast values per specimen for different conditions:

- **Canon**
  - 20180719: only LV, f4 + 1/400
  - 20180612: only LV, f9 + 1/100
  - 20180612: Zc, noLV, f16 + 1/30
- **Nikon**
  - 20180611: norm, LV
  - 20180611: WA, LV
  - 20180611: Grp, noLV, f9 + 1/100
F-STOP & FOCAL QUALITY

Canon

- 20180719
- 20180612
- 20180719
- 20180612
- 20180718
- 20180719

- only
- LV
- f4 + 1/400

Nikon

- 20180611
- 20180611
- 20180611

- only
- norm
- LV
- f9 + 1/100

- only
- WA
- LV
- f9 + 1/100

- only
- Grp
- noLV
- noLV

STOP & FOCAL QUALITY

range (max – min) of st-dev of contrast values per specimen

2.5
2
1.5
1
0.5
0

20180719
20180612
20180719
20180612
20180718
20180719
20180611
20180611
20180611

f4 + 1/400
f9 + 1/100
f16 + 1/30

Canon

Nikon