San Bernardino County Sheriff's Department
CSI Training Unit
Digital Image Processing

I. Overview of Digital Imaging
    a. Sensors
        i. CCD – charged couple device
            1. More expensive
            2. Higher quality image
            3. Uses 100x more power than CMOS
        ii. CMOS – Complimentary Metal-Oxide Semiconductor
            1. Susceptible to "noise"
            2. Less light sensitivity
    b. Film v Digital
        i. Light Values
        ii. Electron Values
        iii. Benefits of digital
            1. ISO value changeable
            2. Better at capturing light
            3. Lower long-range cost
            4. Image preview available
            5. Instant availability of images
    c. Resolution
        i. For computer analysis
        ii. For enlargements
    d. Aspect Ratio
    e. PPI, DPI
        i. Computer image is PPI (pixels per inch)
        ii. Printers print in DPI (dots per inch)
    f. Compression
        i. No-loss compression
        ii. "Lossy" compression – losing pixels
    g. File Formats
        i. Industry Standards
        ii. JPG
            1. Compression photo for storage (loses pixels)
            2. Smallest of three file types (7MB file for 12mp camera)
        iii. RAW
            1. Saves all color value – all pixels
            2. Twice the size of JPG (14MB file for 12mp camera
        iv. TIF
            1. Saves all color value in three layers
            2. Six times the size of JPG (40MB file for 12mp camera)

h. Save v Close
    i. Open and “close” does not change anything about the file
    ii. Open and “save” to close may cause additional compression (pixel loss) depending on type of file
i. Chain of Custody
    i. Who captured image and when
    ii. Who access between capture and court
    iii. Was original image altered in any way
    iv. Who enhanced image, how, and when
    v. Commercial software that will
        1. Encrypt original file to prohibit altering
        2. Track file use (view, copy, print)
        3. Log everything done into a metadata file
        4. Some commercial software is proprietary
j. Capture standards
    i. Minimum NIST requirements
        1. 1000 ppi
        2. Grayscale
k. Compression v Interpolation
    i. Compression
        1. Deletes pixels to save space
        2. Averages surrounding pixels to replace those thrown out
    ii. Interpolation
        1. Used to increase perceived resolution of image
        2. Creates extra pixels in between existing pixels
        3. Extra pixels are average of surrounding pixels
l. Storage and Management
    i. What file type
        1. JPG for most pictures
        2. RAW for any picture that will be used for comparative analysis (Fingerprints, shoe prints, tire tracks, etc.)
    ii. Industry Standards
        1. Redundant long-term storage
            a. Dedicated image server on site
            b. Dedicated image server off-site
        2. Less expensive
            a. Duplicate CDs stored in two different locations
            b. Use quality CDs for long-term storage

II. Equipment and Maintenance
a. Equipment
    i. camera
    ii. Lens
    iii. Filters
    iv. Batteries
    v. Flash

vi. Sync chord
vii. Tripod
viii. Camera bag
ix. Scales
x. Cleaning kit
xi. Camera manual
xii. Ring flash
xiii. Digital image card
xiv. Copy stand

b. Maintenance
    i. Keep equipment in camera bag
    ii. Keep camera bag securely closed always
    iii. Make sure camera is secure on tripod before letting go
    iv. Make sure tripod is stable
    v. Pay attention to where you set your camera
    vi. Don't let strap hang down where it can be snagged
    vii. Don't drive with camera on the car seat
    viii. Keep out of direct sun
    ix. Keep dry
    x. Keep equipment clean
        1. Clean lenses and filters with your breath and a lens cleaning cloth
        2. Wipe off outside of camera and lens bodies with a soft cloth (white t-shirts are great for this)
        3. Keep open ends covered with caps at all times
        4. Only change lenses in a clean & dry environment
        5. Wipe off connecting surfaces of camera and lens when changing lenses often
        6. Have interior of camera professionally cleaned routinely
    xi. Electrical spikes
        1. Remember camera is a handheld computer
        2. Electrical spikes can kill the camera
            a. Always turn camera off when changing batteries
            b. Change all batteries at same time
            c. Use identical batteries – don't mix types or brands
            d. Turn camera off when inserting or removing image cards
            e. Turn camera off when attaching or removing external flash units
            f. Turn camera off when attaching or removing lenses
            g. Turn camera off when attaching or removing and cords or cables
        3. Image cards
            a. Don't put in pocket
            b. Keep in case for image cards

III. Latent Image Processing
    a. Image Calibration
        i. Using scales
            1. Vertical scaling
            2. Horizontal scaling
            3. Drag lines
        ii. 1:1, 2:1, 5:1
    b. Image Processing
        i. Curves
            1. Setting gray scale
            2. How much to adjust
            3. Color channels
        ii. Levels
            1. Setting gray scale
            2. Adjustment limitations
            3. Losing pixel information
            4. Highlights
        iii. B&W
        iv. Color Channels
            1. RGB
            2. CMYK
            3. LAB
        v. Calculations
    c. Making a Court Exhibit
        i. Digital
        ii. Printed
    d. Stitching together
        i. How much overlap is necessary
        ii. How accurate is it
        iii. Automated
        iv. Manual
    e. Exercises Using Photoshop

    Students will use pre-made photos to learn these features then students will take their own photos and have to make correct computer adjustments.

IV. Shoe and Tire Impressions
    a. Image Calibration
        i. Using scales
            1. Vertical scaling
            2. Horizontal scaling
            3. Drag lines
        ii. Straightening
            1. Skew
            2. Ratio locked
            3. Limits

iii. 1:1

b. Stitching Images Together
    i. How much overlap is necessary
    ii. How accurate is it
    iii. Automated
    iv. Manual
c. Exercise Using Photoshop

Students will use pre-made photos to learn these features then students will take their own photos and have to make correct computer adjustments.

V. Crime Scene Image Processing
a. Enhancements
    i. Exposure
        1. Over-exposure
        2. Under-exposure
    ii. Contrast
        1. Adjustments
        2. Limitations
    iii. Hue
        1. Adjustments
        2. Limitations
b. HDR – High Dynamic Range
    i. When is it appropriate
    ii. Advantages
    iii. Disadvantages
    iv. Limitations
c. Stitching Photographs Together
    i. How much overlap is necessary
    ii. How accurate is it

VI. Court Exhibits
a. Latent comparisons
b. Putting known and unknown image on same display page
    i. Create ‘New’ background
    ii. Drag images to new layer
    iii. Leave space for insets
    iv. Create arrow layers to point at comparison points
    v. Elliptical marquee to select comparison points
    vi. Copy and paste for insets

VII. Digital Images and the Law
a. Admissibility of Digital Evidence
    i. Court Challenges
        1. State of WA vs. Eric Hayden 1995
        2. State of CA vs. Phillip Lee 1995
        3. CA Evidence Code Section 1500.6(a)

b. Digital Use Policies
    i. Admissibility of cell phone images
    ii. Download systems
    iii. Storage systems
c. What to Expect in Court
    i. Be able to explain every detail of your procedures
    ii. Be able to re-create I court if asked
    iii. Know the details of the image processing program that you used