Exercise #3 – Fundamental Histogram Analysis, Segmentation and Tracking

DUE: AS INDICATED on Canvas

Please thoroughly read through Chapter 3 & 4 in Computer and Machine Vision by E.R. Davies, as well as through Chapter 4 in Learning OpenCV (on Canvas). Further, read the paper "The world of interactive media systems and applications" and consider the fusion of rendering with computer vision and the concept of rendering a scene that is first fully parsed by computer vision. Do you believe it would ever be possible for computer vision to fully parse and render a scene so that it is indistinguishable from reality? – a Turing test for computer vision.

Exercise #3 Requirements:

1) [5 points] Read the paper "The world of interactive media systems and applications" and summarize key points of the paper. At one point early in the days of ray tracing and computer vision, researchers worried about indistinguishable real video from generated (rendered) video – do you think this was a valid concern?

2) [10 points] Using a single frame from the Laser in a Dark Room, Uncluttered, found here at Dark-Room-Laser-Spot.mpeg, apply the Median filter as documented in our Lecture-Week-5 to the G band only in a graymap and provide an image of before and after filter images in your report - did this help enhance the laser spot edge boundary at all? [Use ffmpeg or avconv to decode and save a single frame from the MPEG video]

3) [15 points] Modify the video, Dark-Room-Laser-Spot-with-Clutter.mpeg and use frame differencing for R,G & B to remove the bookshelf background and to preserve the moving laser spot foreground. Re-encode the difference frames that result. How effective was this at removing clutter? Upload the video with no background with your report.

4) [15 points] Use the Dark Room Laser Spot video and convert the entire video to a grayscale graymap by using the G band (from RGB) only - re-encode the video. Note that frames should be saved as a PGM (see http://en.wikipedia.org/wiki/Netpbm_format) and then re-encoded into MPEG4 using ffmpeg. You can use OpenCV if your wish or your own code to write out the PGM frames.

5) [15 points] Use the Dark Room Laser Spot video you converted to a series of graymap frames (using G band) and write a threshold function based on your analysis of the characteristics of the edges of this spot in the G band - raster each frame to determine the X-bar, Y-bar object COM based on X row maximum extents and Y column maximum extents and your threshold detector. Use the Median Filter and/or Sharpen PSF if you want to

enhance the image prior to threshold detection of the X and Y edges. Mark the COM (Center of Mass) and track it in each frame with cross-hairs (at saturation level of 255 - should appear as white lines) so that the re-encoded video has tracking overlay.

6) [20 points] Repeat above exercise, but modify your threshold for RGB space, use the Light-Room-Laser-Spot-with-Clutter.mpeg, use background elimination first, then apply your COM detector and try to track the spot with an RGB threshold function - re-encode your graphically annotated video. Apply Sharpen PFS and/or the Median filter if you believe this will help with reliable edge detection in RGB.

Upload all video as encoded MPEG-4 at a reasonable bit-rate and quality.

[20 points] Overall, provide a well-documented professional report of your findings, output, and tests so that it is easy for a colleague (or instructor) to understand what you've done. Include any C/C++ source code you write (or modify) and Makefiles needed to build your code and make sure your code is well commented, documented and follows coding style guidelines. I will look at your report first, so it must be well written and clearly address each problem providing clear and concise responses to receive credit.

In this class, you'll be expected to consult the Linux and OpenCV manual pages and to do some reading and research on your own, so practice this in this first lab and try to answer as many of your own questions as possible, but do come to office hours and ask for help if you get stuck.

Upload all code and your report completed using MS Word or as a PDF to Canvas and include all source code (ideally example output should be integrated into the report directly, but if not, clearly label in the report and by filename if test and example output is not pasted directly into the report). ***Your code must include a Makefile so I can build your solution on an embedded Linux system (R-Pi 3b+ or Jetson). Please zip or tar.gz your solution with your first and last name embedded in the directory name and/or provide a GitHub public or private repository link. Note that I may ask you or SA graders may ask you to walk-through and explain your code. Any code that you present as your own that is "re-used" and not cited with the original source is plagiarism. So, be sure to cite code you did not author and be sure you can explain it in good detail if you do re-use, you must provide a proper citation and prove that you understand the code you are using.***

Grading Rubric

[5 points] Read and summarize the main points…

[1 pts] main point #1 _____

[1 pts] main point #2 _____

[1 pts] main point #3 _____

[2 pts] summary overall _____

[10 points] Dark room laser spot median filter G-band transformation and analysis

[6 pts] Application of median filter to video_ _____

[4 pts] Analysis of helpfulness of median filter transform to enhance edge boundaries

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[15 points] Clutter removal from Dark room laser spot with clutter video

[10 pts] R, G, and B background elimination and code to do so well commented_____

[5 pts] Comments on effectiveness for removing clutter and example video re-encoded with background elimination_____

[15 points] Conversion of Dark room laser spot video to grayscale (G band only)

[10 pts] Conversion from RGB to G only grayscale, code to do so, and PGM frames (sampling)

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[5 pts] Re-encoded grayscale only video using ffmepg (avconv)_____

[15 points] Center of laser spot tracking with enhancement as needed to optimize performance

[5 pts] Code and build, test, run to show tracking in grayscale

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[10 pts] Analysis of tracking precision and performance along with steps taken to improve using image enhancement_____

[20 points] Center of laser spot tracking with background elimination in RGB space

[10 pts] Code updates and build, test, run to show tracking in RGB_____

[10 pts] Video encoding to show graphic overlay of center of laser spot so tracking precision can be seen in video_____

[20 points] Quality of reporting and code quality and originality:

[10 pts] Professional quality of reporting, testing and analysis (0…6 is below average, 7 is average, 8 is good, 9 excellent, and 10 is best overall.)_____

[10 pts] Code quality including style, commenting, originality, proper citation for re-used code, modified code, etc._____