Software Engineering Department

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ORT Braude

AOI Enhancement in a Picture According to its Thermal Equivalent

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1 Project Study

Our goal in the following study is the detection of heat signatures/entities and weighted illumination of those areas of interest in a dark image. For that, we plan to use data collected from the equivalent image taken using thermal imaging (grayscale).
What we expect to see is a colored image with entities hidden by normal vision but not by thermal vision, enhanced and seen fairly better, whilst not affecting the other entities in the same picture, a good example of such a picture that needs such enhancement can be seen in Figure 1.

Figure 1 - Thermal Radiation through fog or smoke

2 Project Flow

After a comprehensive study of the subject, we found that using luminance of a thermal image is the simplest way to enhance hidden entities in the equivalent normal image.
We developed a new algorithm based on this assumption, which general flow can be seen in Figure 2.
First, we take both normal image and its equivalent thermal image, and in the preprocessing step, we fit both images to achieve the same zoom and same size, so we can use them for our fusion.
Then, we analyze each image's luminance levels by using the $YCbCr$ color space, where Y is for luminance (e.g., brightness), and Cb and Cr are the blue-difference and red-difference chrominance components. For the normal image we save the data $[Y_1, Cb, Cr]$ per pixel and for the thermal image we save the data Y' per pixel.
In the Luminance Manipulation step, based on a factor $0 \leq \alpha_e \leq 1$, we then use the thermal image luminance Y' (*after thresholding) to brighten the areas of interest in the normal image and the result is $[Y_1 + \alpha_e * Y', Cb, Cr]$.
Finally, we get an enhance image from the normal image by converting the color space back to RGB.
For further enhancement, we can see that the new luminance achieved is in the range $[\min(Y_1 + \alpha_e * Y'), \max(Y_1 + \alpha_e * Y')]$. We can use histogram stretching on the luminance to the range $[0,255]$, as presented in the second lecture, and increase the contrast of the new image.

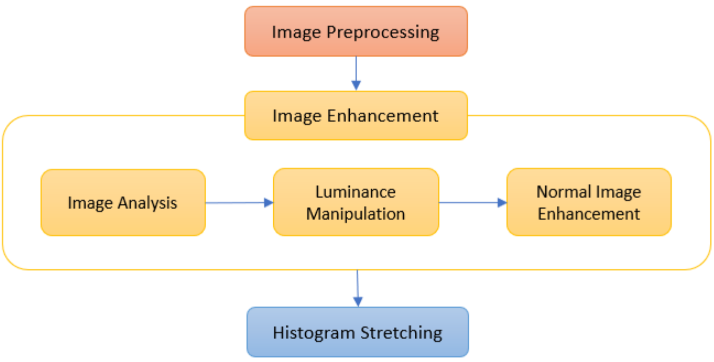

Figure 2 - Algorithm Block Scheme

3 Results

Here we present some examples of pairs of thermal and normal images from the vast collection of images we found in our study, and the results our algorithm achieved for each pair.

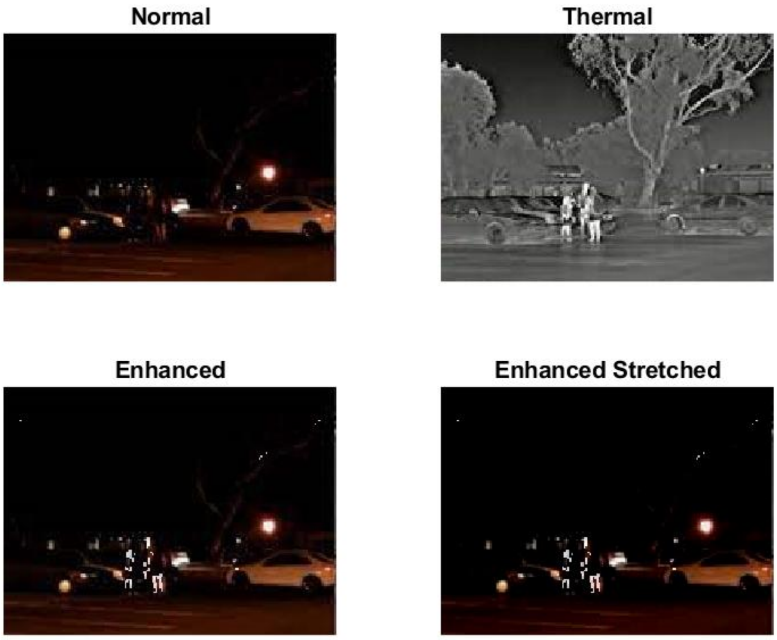

Figure 3

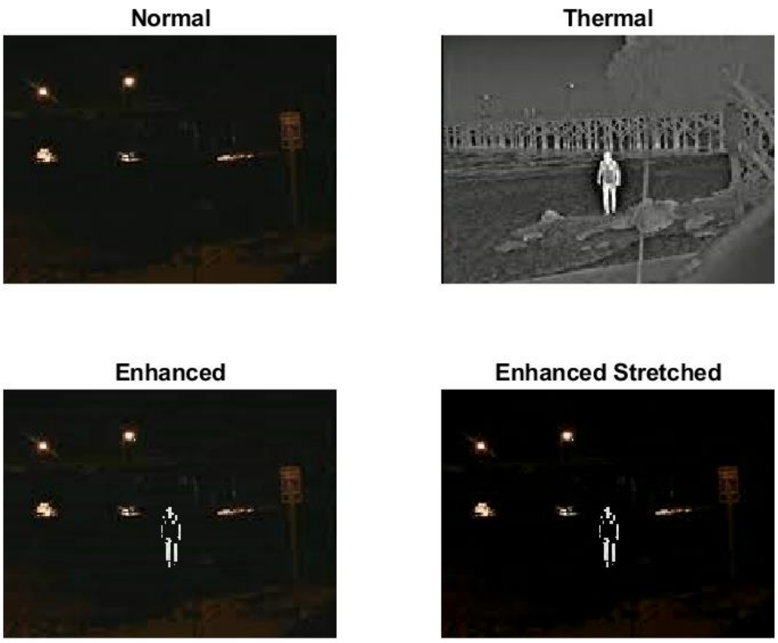

Figure 4

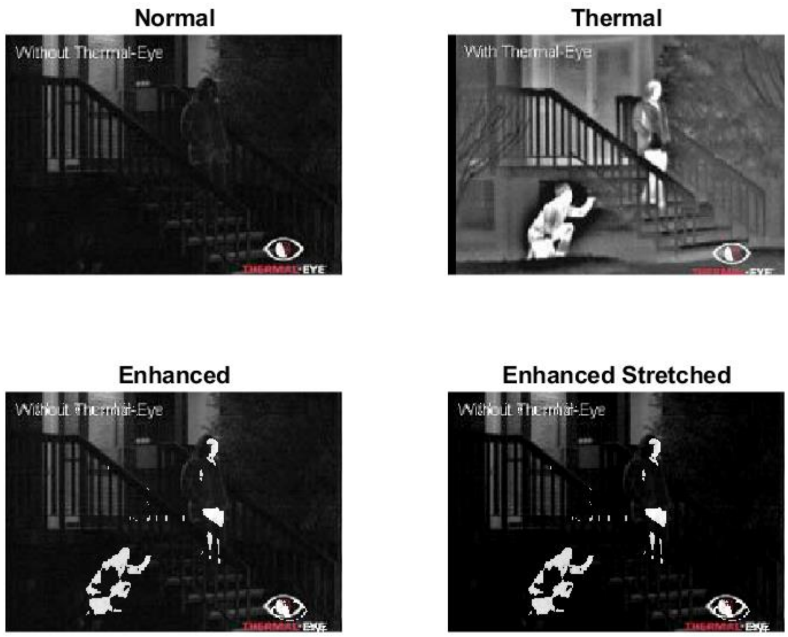

Figure 5

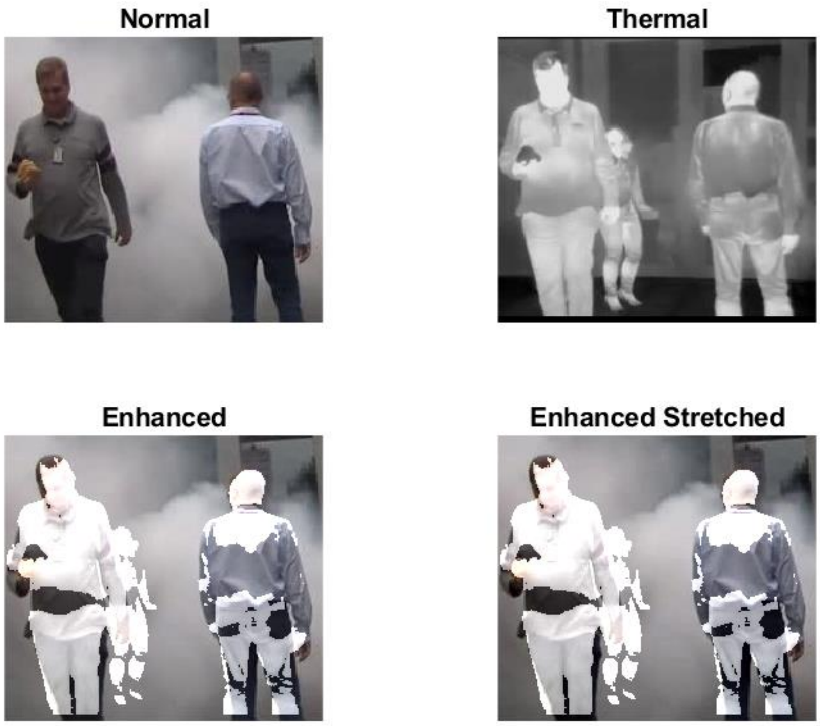

Figure 6

4 Conclusions

In the result images one can see dark entities that have heat signatures as brightened entities and as areas of interest in the dark environment, it's interesting to notice that the effects of the thermal image do not apply on the rest of the normal image.