Practical vignetting correction method for digital camera with measurement of surface luminance distribution (Supplementary material)

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In this supplementary material the additional research results are shown. The references to figures are included in the order as they appear in the article.

The impact of change of vignetting characteristic from radial to non-radial on the correction results obtained for the radial polynomial and local parabolic models (Fig. SM1). To obtain images with similar vignetting characteristics as images from Basler-NET system with non-radial vignetting, the new images were created by stretching images from Canon system with radial vignetting along one axis. The values of stretching coefficients were equal to: 105%, 120% and 140%. Two models which give the best results in vignetting correction for Canon system or Basler-NET system have been selected for comparison. The results show that quality of vignetting correction of new images does not change in the case of local parabolic model, but drastically decreases in the case of radial polynomial model. This experiment clearly shows that in the case of vignetting with a minimal non-radiality the new model should be used.

The influence of different methods of vignetting correction is presented on the 6 images of various indoor and outdoor objects (Fig. SM2). In order to better present the vignetting correction results each corrected image is shown as the whole image in both grey levels and in pseudocolours, additionally for each image is shown its enlarged fragment. The relation between grey level values and pseudocolour palette is presented in Fig. SM3. The presented images are divided into two parts: the upper half of the image shows the image before correction and the lower half of the image shows the image after correction (Fig. SM4 – SM9).

The comparison of calculation time of vignetting functions is presented in Fig. SM10. The performed tests showed that the local parabolic model have the shortest calculation time of considered methods.

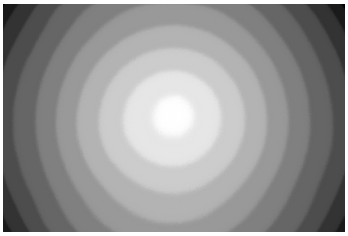
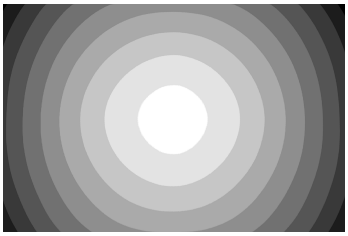
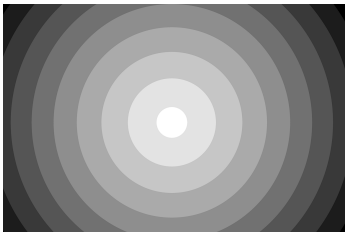
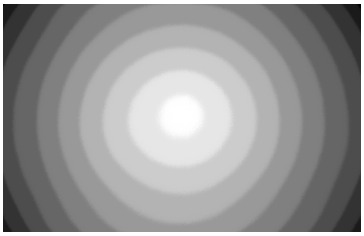
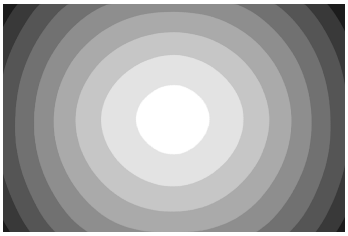
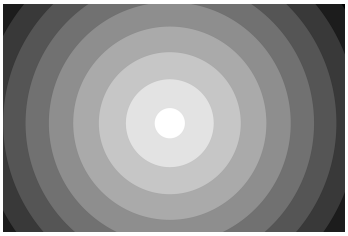
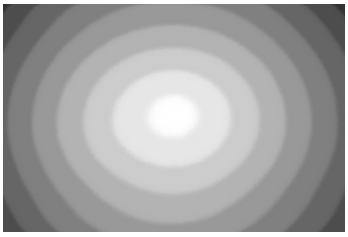
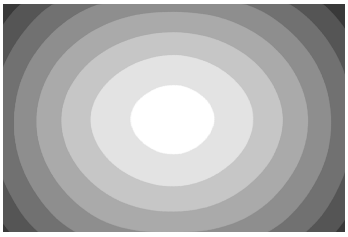
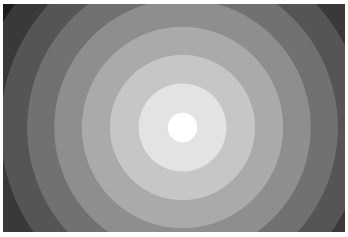
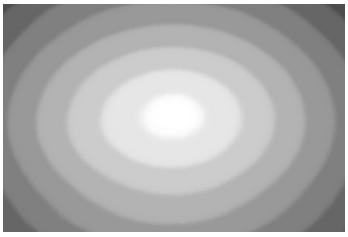
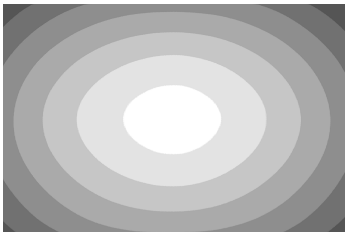
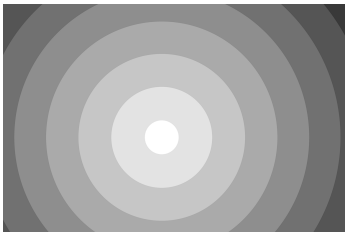
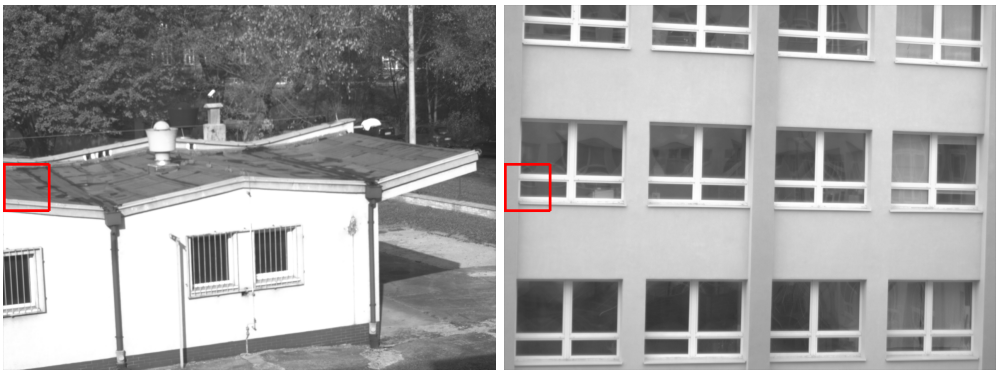
Width	Original image	Local parabolic model	Radial polynomial model
100%			
		MAE = 0.54	MAE = 0.44
105%			
		MAE = 0.55	MAE = 0.56
120%			
		MAE = 0.55	MAE = 1.49
140%			
		MAE = 0.55	MAE = 1.82

Figure SM1: Comparison of vignetting correction results of radial and non-radial vignetting with use of local parabolic model and radial polynomial model

(a) Trees (b) Sky



(c) Building (d) Windows

(e) Keyboard (f) Plants

Figure SM2: The greyscale images: (a) Trees, (b) Sky, (c) Building, (d) Windows, (e) Keyboard and (f) Plants. The enlarged fragment of each image is shown by red square

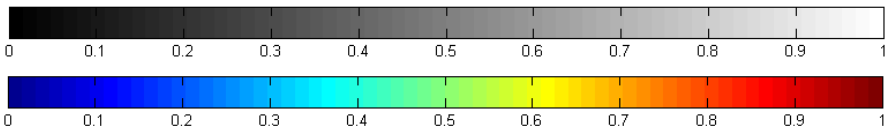
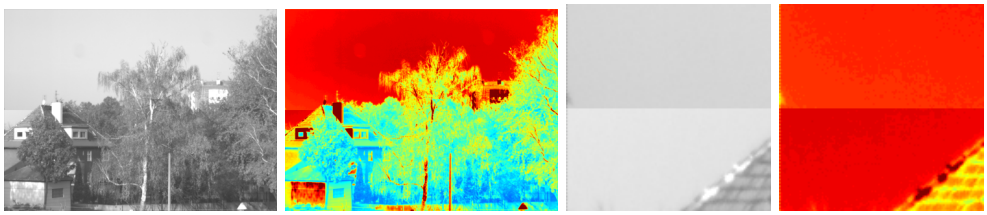
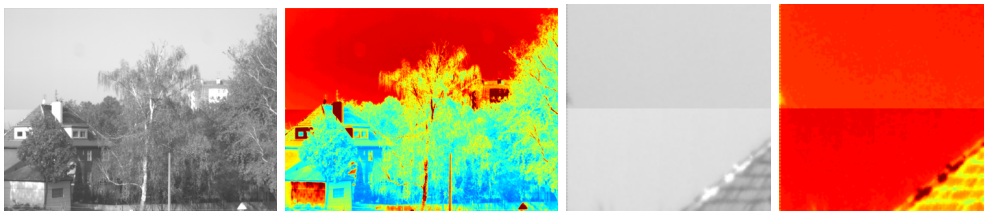


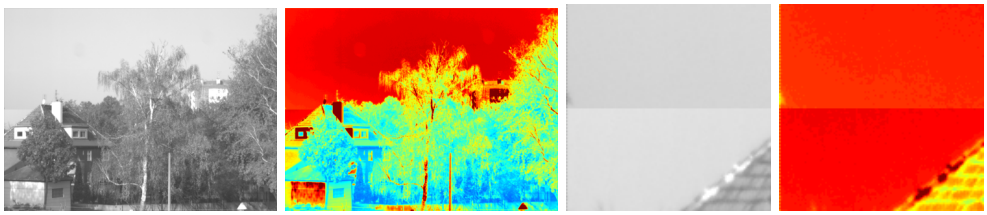
Figure SM3: The colour scale used in image pseudocolourization



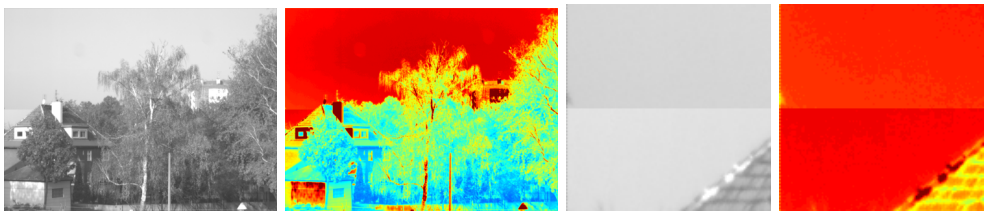
(a) Local parabolic model



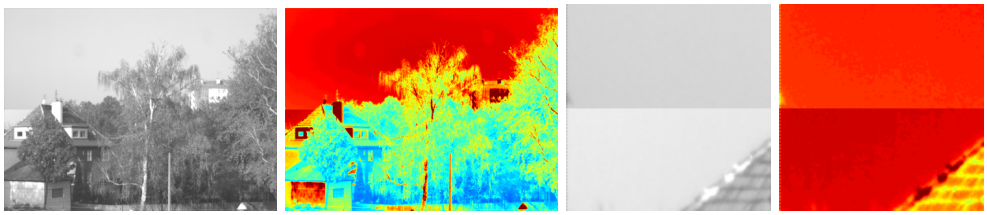
(b) Polynomial model



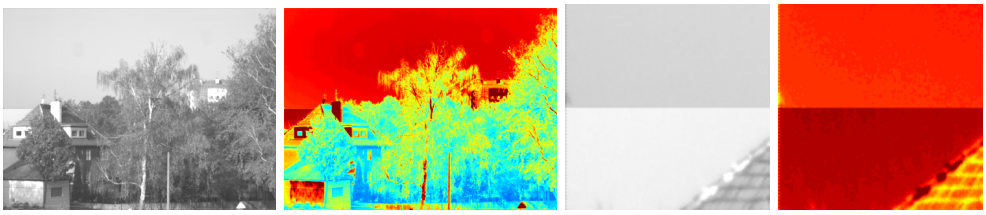
(c) Exponential polynomial model



(d) Hyperbolic cosine model

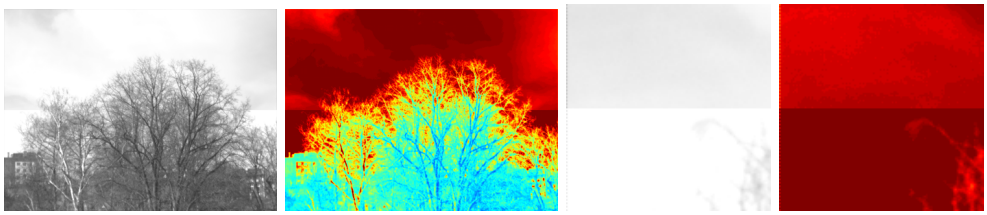


(e) Gaussian function

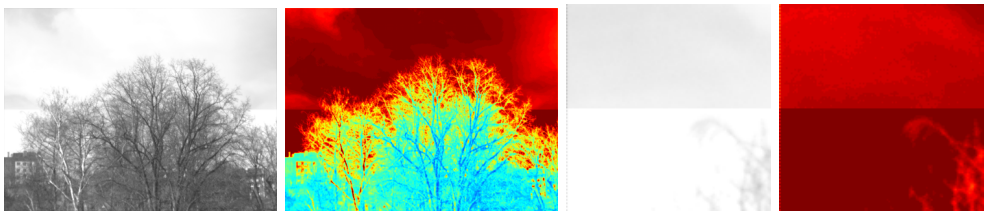


(f) Radial polynomial model

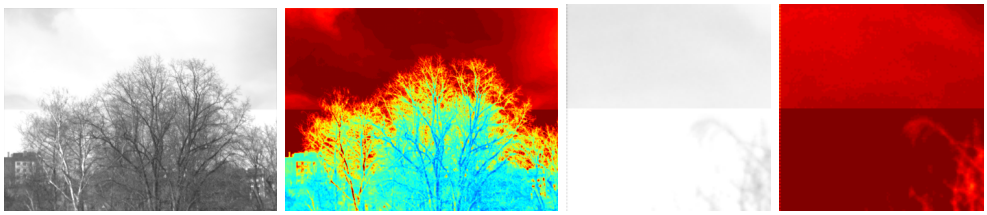
Figure SM4: Natural image TREES and its enlarged fragment before (top half of image) and after (bottom half of image) vignetting correction with use of: (a) local parabolic model, (b) polynomial model, (c) exponential polynomial model, (d) hyperbolic cosine model, (e) Gaussian function and (f) radial polynomial model



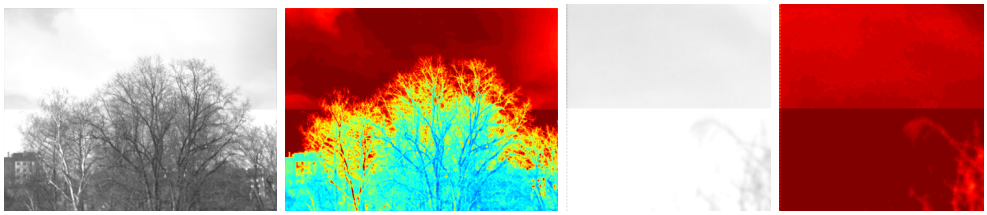
(a) Local parabolic model



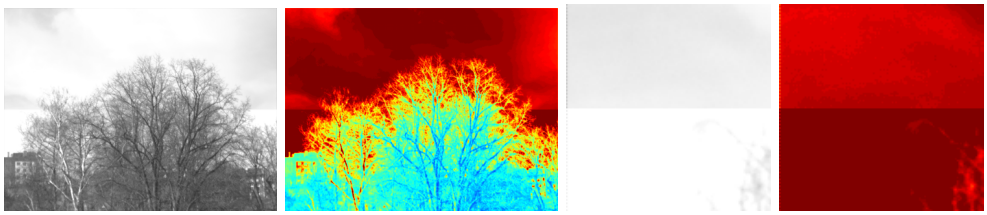
(b) Polynomial model



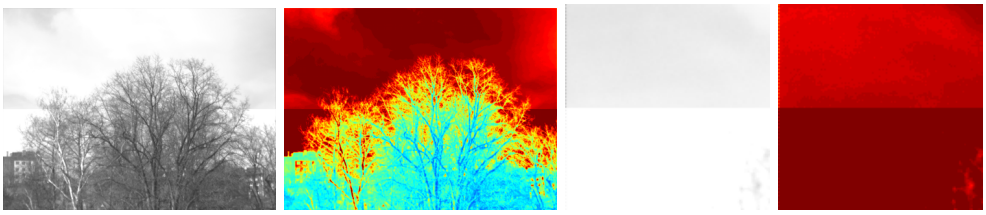
(c) Exponential polynomial model



(d) Hyperbolic cosine model

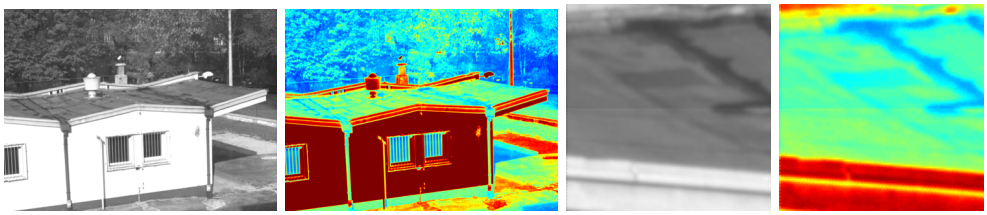


(e) Gaussian function

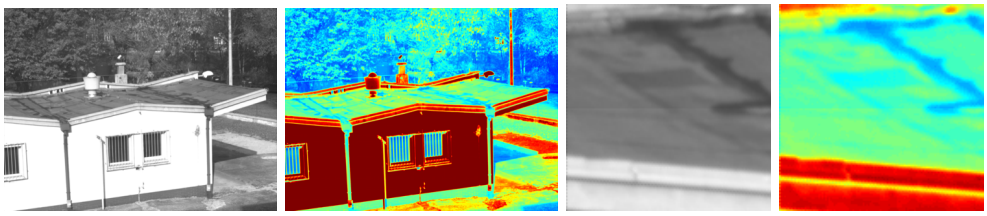


(f) Radial polynomial model

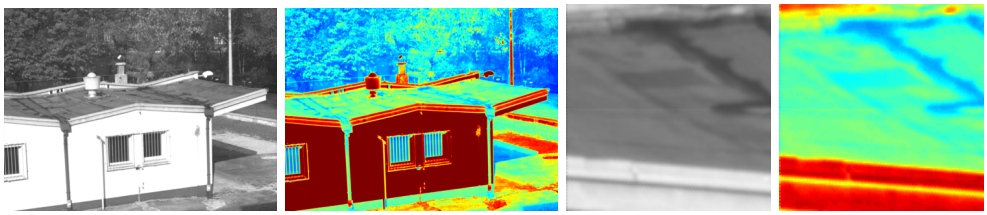
Figure SM5: Natural image Sky and its enlarged fragment before (top half of image) and after (bottom half of image) vignetting correction with use of: (a) local parabolic model, (b) polynomial model, (c) exponential polynomial model, (d) hyperbolic cosine model, (e) Gaussian function and (f) radial polynomial model



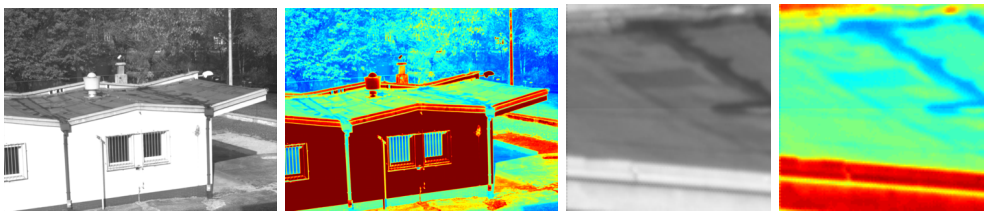
(a) Local parabolic model



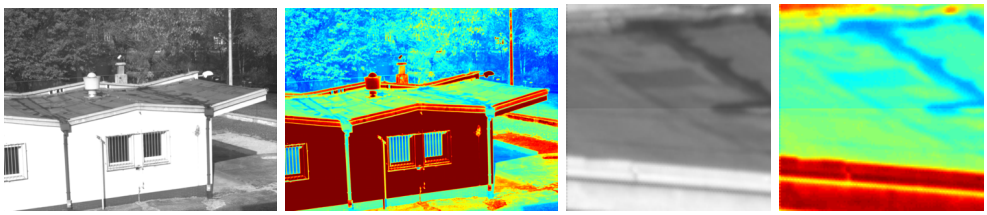
(b) Polynomial model



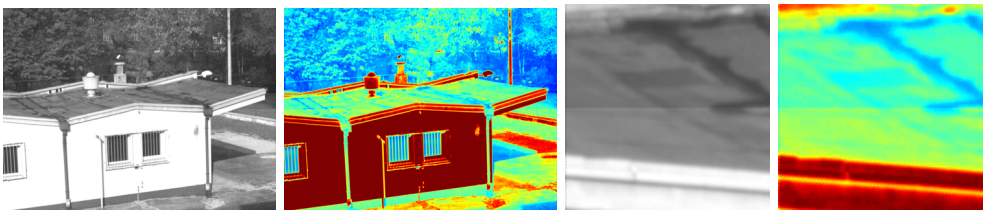
(c) Exponential polynomial model



(d) Hyperbolic cosine model

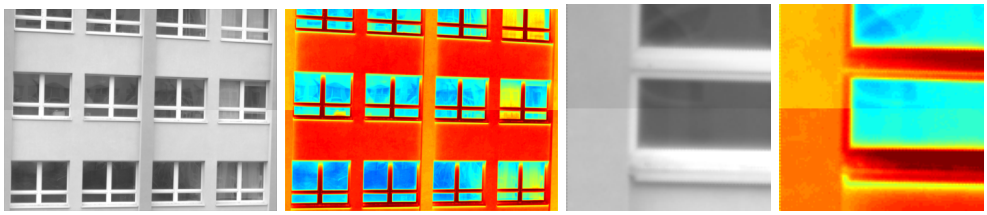


(e) Gaussian function

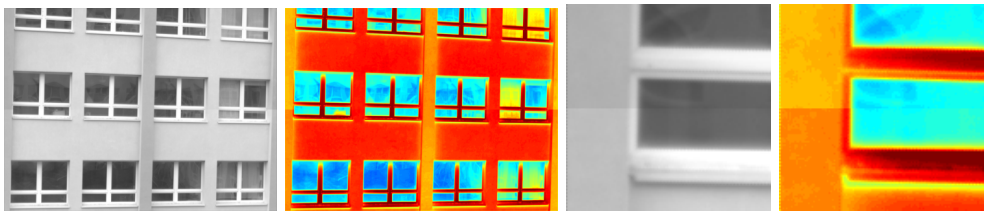


(f) Radial polynomial model

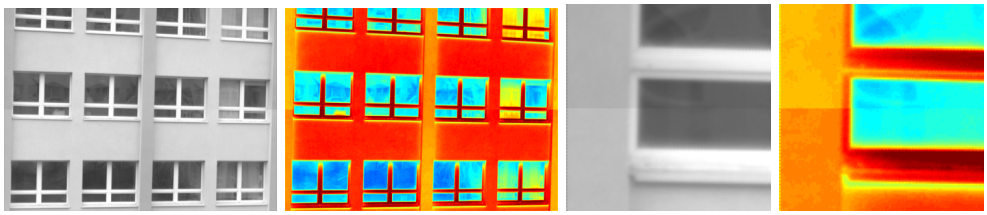
Figure SM6: Natural image BUILDING and its enlarged fragment before (top half of image) and after (bottom half of image) vignetting correction with use of: (a) local parabolic model, (b) polynomial model, (c) exponential polynomial model, (d) hyperbolic cosine model, (e) Gaussian function and (f) radial polynomial model



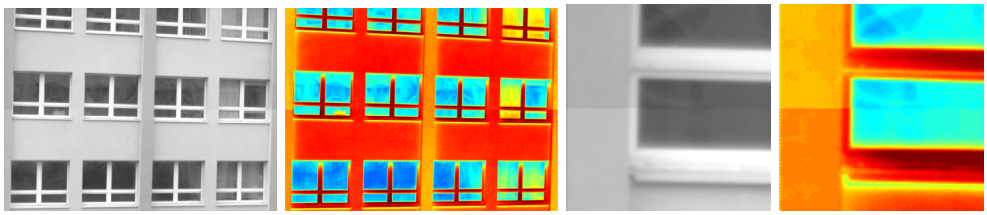
(a) Local parabolic model



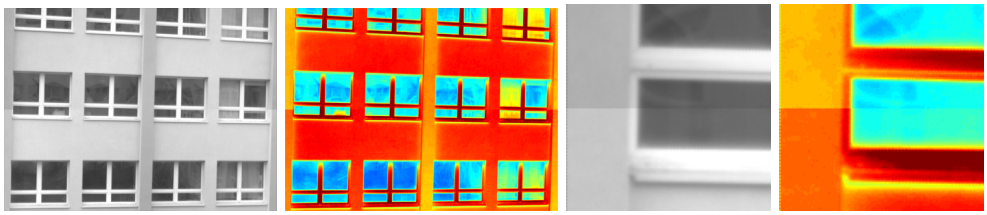
(b) Polynomial model



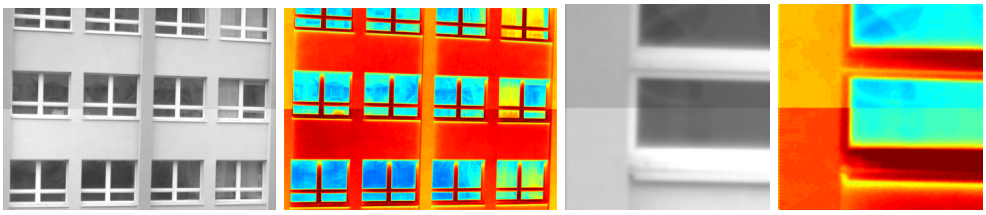
(c) Exponential polynomial model



(d) Hyperbolic cosine model

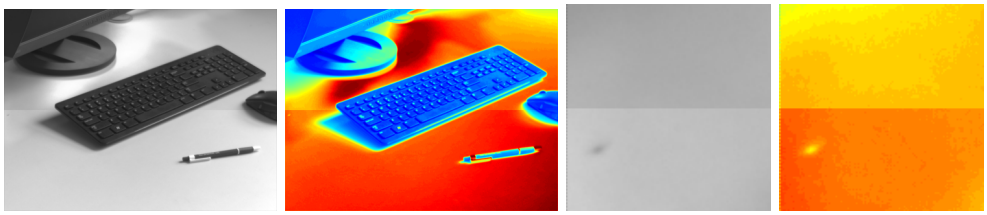


(e) Gaussian function

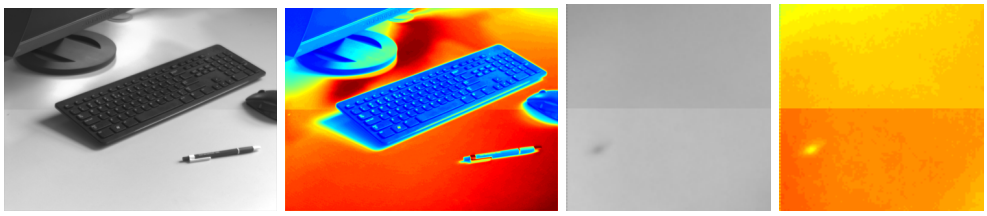


(f) Radial polynomial model

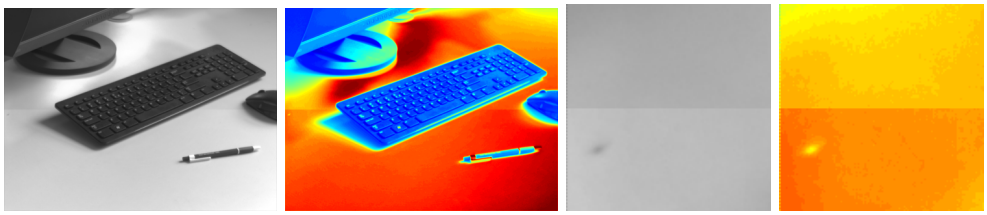
Figure SM7: Natural image WINDOWS and its enlarged fragment before (top half of image) and after (bottom half of image) vignetting correction with use of: (a) local parabolic model, (b) polynomial model, (c) exponential polynomial model, (d) hyperbolic cosine model, (e) Gaussian function and (f) radial polynomial model



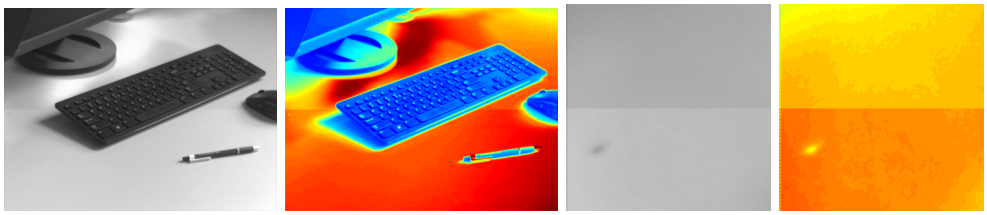
(a) Local parabolic model



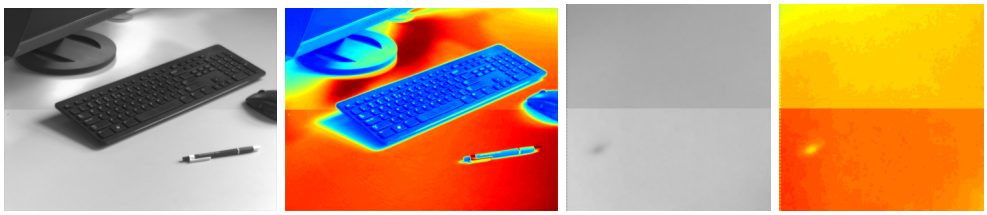
(b) Polynomial model



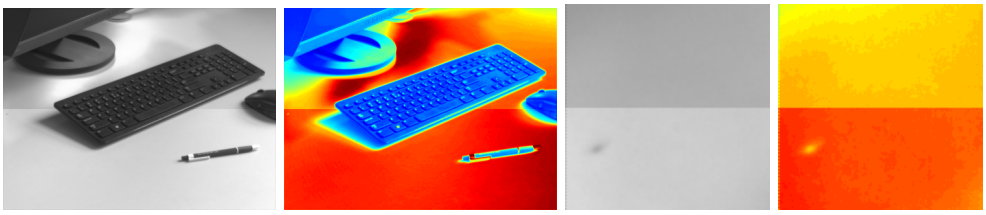
(c) Exponential polynomial model



(d) Hyperbolic cosine model

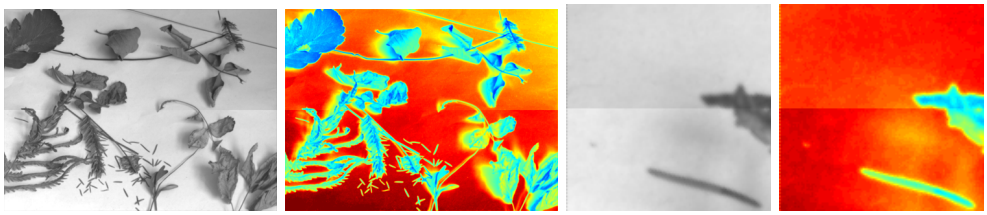


(e) Gaussian function

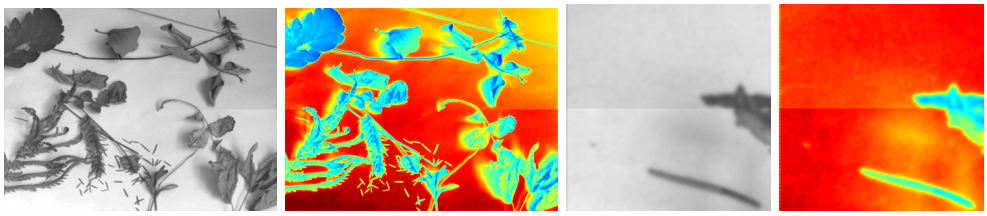


(f) Radial polynomial model

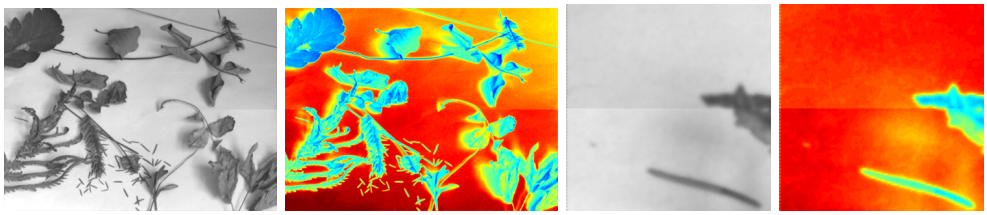
Figure SM8: Natural image KEYBOARD and its enlarged fragment before (top half of image) and after (bottom half of image) vignetting correction with use of: (a) local parabolic model, (b) polynomial model, (c) exponential polynomial model, (d) hyperbolic cosine model, (e) Gaussian function and (f) radial polynomial model



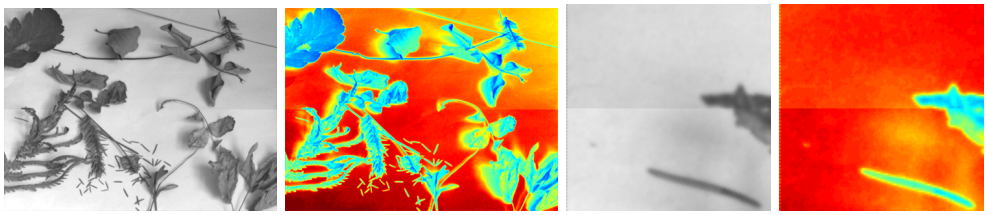
(a) Local parabolic model



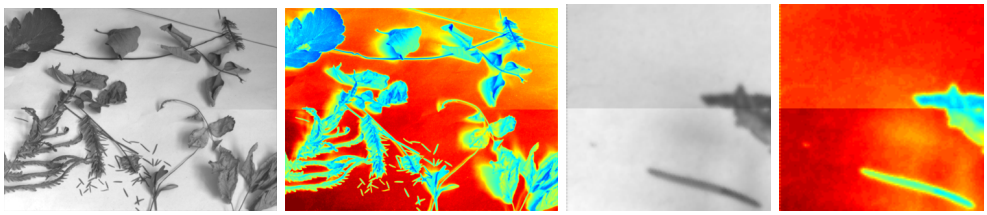
(b) Polynomial model



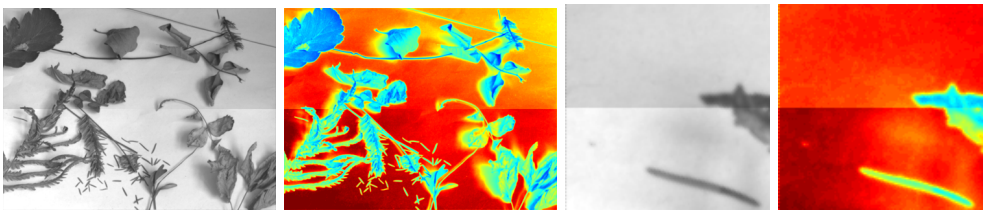
(c) Exponential polynomial model



(d) Hyperbolic cosine model



(e) Gaussian function



(f) Radial polynomial model

Figure SM9: Natural image PLANTS and its enlarged fragment before (top half of image) and after (bottom half of image) vignetting correction with use of: (a) local parabolic model, (b) polynomial model, (c) exponential polynomial model, (d) hyperbolic cosine model, (e) Gaussian function and (f) radial polynomial model

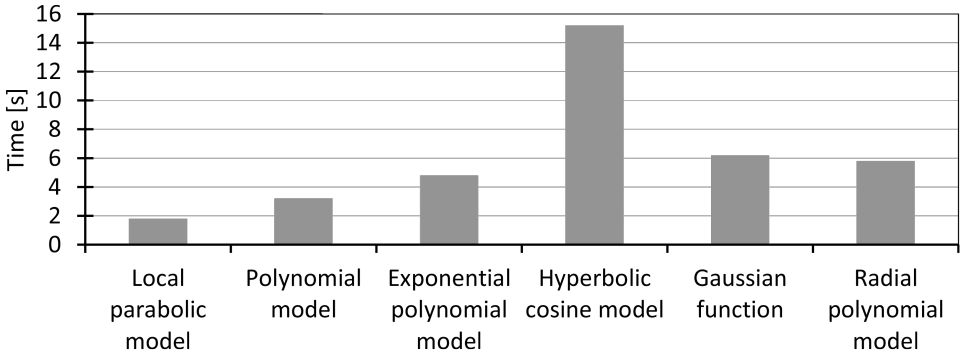


Figure SM10: The calculation time of vignetting functions