Evaluation of thermal image point spread function as priors to enhance resolution of deconvoluted images

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- Introduction

Thermal imaging has a wide variety of applications from night vision to medical fields. There is potential to substituting X-rays by thermal imaging in non-life-threatening applications. One of such use is in evaluating limping in children[1].

Thermal imaging acquisition has typically been costly due to use expensive and specialized, cooled, sensors. IR thermal imaging present resolution limitations due to the dimensions of the IR focal plane and sensor accuracy[2]. A low-cost version of thermal cameras using microbolometers, has recently become popular. The camera acquisition cost is low. However, it suffers from low resolution. The computational enhancement of image resolution has advantages over the cost and pixel size and noise related limitations present on sensor design.

The resolution of images produced with low cost thermal cameras can be enhanced with use of multiple images. There are two implementations of proposed algorithms[2] that have potential to be used in this study.

A) Kiran, et al.[2] used single image pairs and linear interpolation algorithms to create priors used in enhancing the resolution of low-resolution thermal imaging.

B) A second approach is based on evaluation of ordinary content-specific image priors to enhancing RGB photographs[4]. The Luma channel of ordinary images may be used as the basic model to evaluate priors for thermal imaging analysis.

The goal of this study is to implement a low-cost thermal based camera system to acquire ordinary images on human subjects, and study the used of priors to enhance the low resolution typically obtained with use of imaging produced by low cost thermal cameras.

- Related work

Kyran, et al.[2] developed an algorithm to improve the resolution of single thermal images. A training data set was built based on self-examples created by applying a method that recursively scaled and interpolated image patches. This approach does not rely on external data bases. A regression operator represented in a matrix form was used as a prior was used to resolve the low-resolution images. This prior is obtained from the relation between self-example patch pairs.

This approach has the advantage of not relying on external data sets that reduces the complexity and lower the real time computational requirements for image processing.

The implemented bi-pyramidal algorithm is reported to be efficient. The self- examples are extracted from spatially close of two different scales. The image patches are extracted from same locations of the up-scale and down-scale versions of the input image. Thus, this approach has a few key features that is appeals for use with low resolution thermal cameras. The method is reported to be efficient, does not rely on external data sets and has been applied to single low-resolution thermal images.

Dai et al.[3] studied image priors for images with soft edges with gradual intensity transitions. Intensity images were used in the approximation of the average length of all level lines in a proposed soft edge smoothness measurement. Edge smoothness priors may be able to suppress jagged edge artifacts. IR thermal image priors have been studied as broadly as the priors obtained on RGB cameras. However, this nonspecifically developed and tested for IR thermal image prior. This prior may potentially be borrowed and evaluated for thermal images.

Similar to RGB photography, in many cases low cost thermal cameras require automated simple methods to correct image artifacts. Josh[4] used image models that incorporated prior information for image correction and enhancement. Instead of using generic priors, however, methods that use priors were tuned to the specific image content. A background on the basic area of blur kernel estimation and blind deconvolution have been addressed as a general area.

Estimating blur kernel to performing blind deconvolution is a challenging issue. Single image blind deconvolution has two facets, the use of parametric and non-parametric models of PSFs. The majority of work on blur estimation has been done on parametric kernels. It is proposed in this study to verify the use of RGB priors, similar to the ones reported in this dissertation, and investigating their behavior in thermal imaging. This dissertation serves as a good compilation of information to using priors, such as gradient priors. Also, the PSF estimation using sharp edge prediction approach assumes that all edges in a sharp image are step-edges. Josh's algorithm predicts the sharp version of a blurry input image and uses two images to obtain a PSF.

- Approach (Your model/algorithm and hardware/datasets/computing resources required)

- Milestones and timeline

Week1:

Order, assemble the low resolution Flir camera, Thermal_Lepton and the raspberry Pi 3B single board computer. Install the unit on tripods to collect imaging of motionless human subjects.

Week2:

Calibrate the system.

Week3:

Implement algorithms from items a) based on Kiran et al. [2], and b) Joshi, N.S.[4] (see Introduction).

Week4:

Evaluate PSNRs and image qualities from implemented algorithms, compare results with single original images (without enhancements).

Complete analysis and write report.

- References

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