**SUPER RESOLUTION: A SPATIAL SUBPIXEL INTERPOLATION TECHNIQUE**

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**Abstract**

Super resolution describes the process of creating a higher resolution image using one or multiple low resolution images. In this paper we will focus on the method based on multiple low resolution images, presenting its advantages and disadvantages. Finally, we will present the challenges which future research is faced with.

The need for this field stems from applicability in important areas such as machine image perception and human image interpretation, where high end image capturing hardware isn’t feasible or cost efficient.

**Introduction**

**Problem motivation**

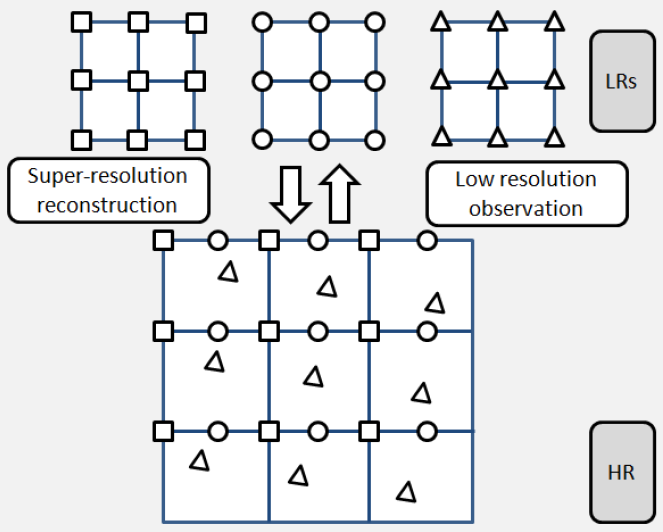
The main limitation of image acquisition is the imaging sensors of the device used. The modern image sensor is typically a charge-coupled device (CCD) or a complementary metal-oxide-semiconductor (CMOS) active-pixel sensor. The two types are typically arranged in a two-dimensional array to capture two-dimensional image signals. The spatial resolution of the image to capture is directly influenced by the sensor size or equivalently the number of sensor elements per unit area. Higher density of the sensors means higher spatial resolution possible for the imaging system. An imaging system with inadequate detectors will generate low resolution images with blocky effects, due to the aliasing from low spatial sampling frequency. To increase the sensor density will bring issues such as causing “shot noise” [1], increasing hardware cost and sensor size.

While the image sensors limit the spatial resolution of the image, the image details (high frequency bands) are also limited by the optics, due to lens blurs (associated with the sensor point spread function (PSF)), lens aberration effects, aperture diffractions and optical blurring due to motion. The construction of imaging chips and optical components able to capture very high-resolution images is expensive and not practical in most real applications. One example is the widely used surveillance cameras. Besides the cost, the resolution of a surveillance camera is limited in the camera speed and hardware storage.

Another way to address this problem is to accept the image degradations and use signal processing to post process the captured images, to trade off computational cost with the hardware cost. These techniques are specifically referred as Super-Resolution (SR) reconstruction.

Super-resolution (SR) us the concept of constructing high-resolution (HR) images from several observed low-resolution (LR) images, thus increasing the high frequency components and removing the degradations caused by the imaging process of the low resolution camera. By combining the non-redundant information contained in multiple low-resolution frames, we can generate a high-resolution image. A closely related technique with SR is the single image interpolation approach, which can be used to increase the image size, but without additional information provided, the quality of the single image interpolation is limited due to the ill-posed nature of the problem and in some cases add no value. In the SR setting, however, multiple low-resolution observations are available for reconstruction.

The non-redundant information contained in the these LR images is typically introduced by subpixel shifts between them. These shifts may occur due to movements of objects, or due to controlled motions, like the imaging system having a predefined speed and path. Each low-resolution frame is a decimated, aliased observation of the true scene, thus SR is possible only if subpixel motions between these low resolution frames exist.



[2]

In the imaging process, the camera captures several LR frames, which are down sampled from the HR scene with subpixel shifts between each other. SR construction reverses this process by aligning the LR observations to subpixel accuracy and combining them into a HR image grid(interpolation), thereby overcoming the imaging limitation of the camera. SR (some of which described in this book), arises in many areas such as:

1. Surveillance video [3][4]: frame freeze and zoom on regions of interest (usages consist of automatic target recognition and human perception: license plates, faces etc.)
2. Medical imaging (CT, MRI, Ultrasound) [5][6]

**Related word**

**Proposed method**

**Implementation**

**Evaluation**

**Discussion**

**Performance measurements**

**Conclusions**

**Current state**

**Future work**

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