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An Introduction to Super-Resolution Text

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14.1 Introduction

The quest for high-resolution images or image sequences from a cheap and small acquisition system is a challenge rooted deeply in both hardware and software. While hardware advances in leaps and bounds in terms of more powerful yet smaller footprint processors, sensors and memory, the progress of software and appropriate algorithms requires longer-term research and development.

Due to the increased use of embedded low-resolution imaging devices, such as handheld PDAs and mobile phones, coupled with the need to extract information accurately and quickly, super-resolution (SR)-based techniques are fast becoming a focus of research in the field of text recognition. SR processes the information from one (or more) low-resolution (LR), possibly noisy and blurred, image(s) of a scene to produce a higher resolution image (or sequence). A typical application scenario may be the use of a mobile phone camera to capture one or more lines of text on an advertising poster while on a metro train. The result may be a shaky low-resolution image sequence. This could possibly be sent to a server for transformation into text or be done on the fly on the phone if (one day) enabled. Other applications that may require SR text pre-processing include a tourist translation assistant or a text-to-speech transformation for the visually impaired.

Classical image restoration algorithms resulting in a single output image from a single degraded image are sometimes referred to as *single-input single-output (SISO) super-resolution*. Even though some may disagree with such a categorization, high-resolution (HR) information missing in a single LR image can be recovered by training models to learn piecewise correspondences between LR and possible HR information to form an SR image.

A possible application of SISO super-resolution is for face resolution enhancement to add details and enable to zoom-in in the image.

Most SR algorithms deal with the integration of multiple LR frames to estimate a higher resolution image. The most common term of reference for multiple frame super-resolution found in the literature is *multiple-input single-output (MISO)* or *static super-resolution*. An example application area is in licence plate recognition from a video stream to increase the alphanumeric recognition rates.

A recent focus of SR research relates to *dynamic super-resolution*, which is aimed at reconstructing a high-quality set of images from low-quality frames, often referred to as *multiple-input multiple-output (MIMO) super-resolution*. This approach is also known as *video-to-video super-resolution*. For example, applications can be found in video enhancement captured by surveillance cameras to increase the general visibility and acuity of a recorded criminal event.

Figure 14.1 illustrates the three methods outlined above. SR methods can be found in a multifarious range of imaging applications, such as remote sensing, microscopy and medical imaging, astronomical and space imaging, surveillance and forensic imaging and many more. (For more details on general super-resolution and its applications, the reader is referred to [1].) In this chapter the focus is on the application area of text analysis: how can SR be used in the generation of higher quality text images that can be more accurately interpreted by in-house or off-the-shelf OCR software? We concentrate on MISO or static SR methods since this is the most appropriate area of SR likely to have immediate impact in terms of multiple input frames from a mobile device, e.g. capturing information from a business card, a restaurant menu or a map with printed text.

Most articles dealing with SR text consider cropped sequences of detected text areas [2–4]. As SR techniques can be computationally expensive, then processing regions of interest only is both cost saving and allows the algorithm to focus more towards local properties. In this chapter, we do not

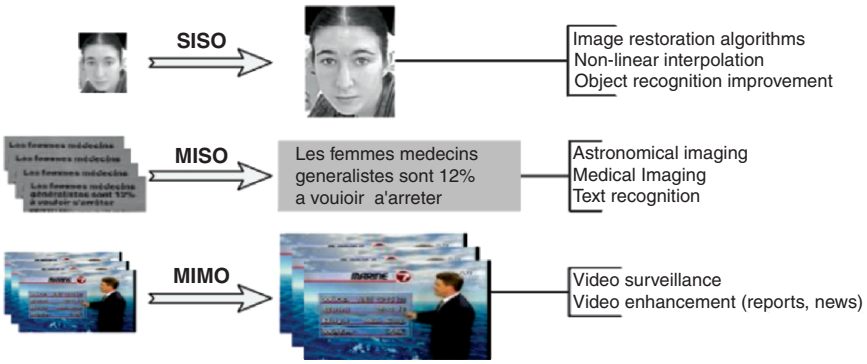

Fig. 14.1. Categories of super-resolution and some example applications.