STSM Report

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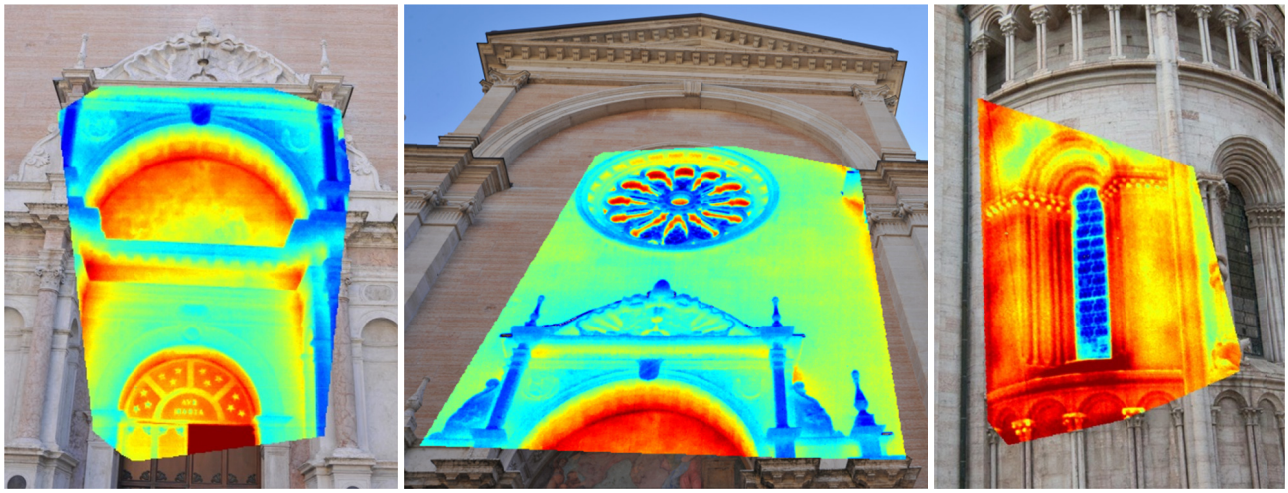
The Short Term Scientific Mission (STSM) aimed at the development of methodologies and algorithms for the integration of different spatial/spectral data with particular attention to the analysis of large Cultural Heritage objects (buildings, monuments, etc.). In particular the outcome of this STSM consists in the development of methodologies and algorithms for the registration of images acquired by different cameras considering the RGB-to-RGB and RGB-to-Thermal registration tasks.
In particular, an algorithm for the registration of thermal and RGB images, acquired from unknown positions, has been developed. The spectral information of these two typologies of images can be very different and the texture of the thermal image is usually very reduced (as it depends on the surface temperature variations). In the STSM a modified version of the SIFT operator was developed. Points are extracted using the standard SIFT feature detector on the smoothed images: 3 octaves and 8 different scales are considered for each image. Then, the information provided by image edges are used to define the descriptor: for each image of the Gaussian scale, the Canny operator is run and the descriptor is computed for each keypoint using the edge information.
The main orientation is firstly defined considering the principal orientation in a region around each keypoint: this value is computed using the cumulative frequency of each edge orientation in that region. Anyway, any information about the radiometric gradient can be considered as gradients on RGB and thermal images appear very different and the main direction of each keypoint cannot be estimated. To fix this ambiguity, two descriptors are computed, one the "specular" of the other (main direction is changed of 180°). Each descriptor is composed of 8 by 8 bins: for each bin the cumulative frequency of 8 main directions are computed and these values are stored in a 512-numbers descriptor.
Several keypoints can have very similar descriptors and the choice of the best matching can be very difficult. A two-step approach has been studied for the detection of correct matches. In the first step, a soft matching is exploited in order to solve the orientation ambiguity of the images and provide an approximate registration of the images; then a refinement of the matching is defined in the second step. In each step a RANSAC algorithm and the homographic model are considered to remove the wrong matches between images and to deliver the correct relative position between images.
The registration between RGB and thermal images was tested on several images on different facades; below some examples are shown.



Examples of registration between RGB and thermal images.