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Automatic thermographic inspection of buildings envelope using laser and thermal images

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Abstract. This paper describes an automatic system that detects thermal insulation properties of the different components of buildings envelope by combining laser data with thermal images. Sensor data is obtained from a moving vehicle equipped with a GPS sensor. Range data is integrated to obtain the 3D structure of the building facade, and combined with thermal images to separate components such as walls, windows frames and glasses. Thermal leakage is detected by detecting irregularities in the thermal measurements of each component separately.

1 Introduction

The use of infrared thermography as a tool to quantitatively identify irregularities in the heat, cold and moisture properties of the buildings envelope has become an important research field in the last few years. Only in the EU the building sector accounts for 40% of the energy requirements and offers the largest single potential for energy efficiency [1]. Thermographic inspections have been usually carried out by thermographers by means of manual labelling of thermal images. Recently, mobile thermal scanning systems have been proposed to capture data from the ground, surveying hundreds of buildings in a short period of time [2]. However, the recorded images are off-line analysed including a considerable amount of manual supervision work. Automatic interpretation of thermal images to detect thermal leakage on buildings has been recently proposed, including the detection of building components such as windows and doors [3]. In this work, we propose to combine the use of laser data with thermal image analysis to automatically detect thermal insulation properties of the different components of buildings envelope.

2 System Description and Results

A commercial vehicle has been equipped with an infrared camera, a four layers laser scanner and a GPS system. The extrinsic relationship between the camera and the laser is obtained using the calibration procedure proposed in [4]. In our case, the chessboard pattern is previously heated up to make visible the squares to the infrared sensor. Range measurements are integrated in the space

using the global position of the vehicle. A simple state machine is used to detect the boundaries of the buildings. Panoramic images are obtained when building facade exceeds the limits of the camera resolution, matching SURF features that satisfy the planar homography, that is, features that correspond to the plane defined by the facade. Each facade is thus isolated, including thermal and range information. 3D data is firstly used to segment windows glasses, since they produce holes in the 3D reconstruction of the facade. Then, rectangular regions surrounding the windows glasses are detected to separate the windows frames. Finally, a growing regions approach is applied to obtained the remaining areas corresponding to walls. Some results are depicted in Figure 1.

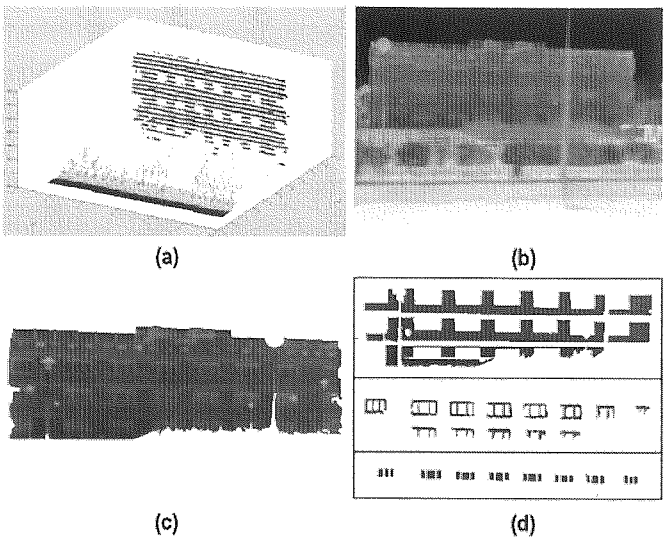

Fig. 1. (a) 3D reconstruction of the facade; (b) Segmented building with thermal information; (c) Isolated facade; (d) Walls, window frames and glasses segmentation.

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