Sensitivity of different methods for simultaneous evaluation of emissivity and temperature through multispectral infrared thermography simulation

Thibaud Toullier, Jean Dumoulin, Laurent Mevel

To cite this version:

Thibaud Toullier, Jean Dumoulin, Laurent Mevel. Sensitivity of different methods for simultaneous evaluation of emissivity and temperature through multispectral infrared thermography simulation. EGU 2019 - European Geoscience Union, Apr 2019, Vienne, Austria. 21, pp.1, 2019. hal-02264677

HAL Id: hal-02264677
https://hal.archives-ouvertes.fr/hal-02264677
Submitted on 7 Aug 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
### Introduction and nomenclature

This study focuses on the simultaneous evaluation of temperature and emissivity with multispectral infrared thermography (IRT). It leans on the study and development of an IRT simulator able to address 3D scene in static or dynamic configuration. The sensitivity of 4 different temperature and emissivity joint estimation methods are then evaluated.

#### IRT Simulator through the radiosity method

View factor

Geometrical coefficient for radiative exchange between two diffuse elements

\[
F_{k,j} = \int_{A_{k}} \frac{\cos(\theta_{k}) \cos(\theta_{j})}{\pi r^2} dA_k dA_j
\]

Radiosity equation

\[
B_k(\Delta_i) = M_k(\Delta_i) + (1 - \varepsilon_{\Delta_i}) \sum_{j=1}^{N} V_{jk} F_{k,j} B_j(\Delta_i)
\]

With Bouguer’s law and for infinitesimal surfaces:

\[
E_{\text{sensor}, \Delta_i} = \int \frac{L(\Delta_{\text{sensor}}, \theta)}{d^2} \text{d} \theta = \int \frac{L(\Delta_{\text{sensor}}, \theta)}{d^2} \text{d} \Delta_i
\]

\[
\Rightarrow \quad \text{Undetermined system with } \varepsilon_{\Delta_i} \text{ and } T \text{ unknowns}
\]

\[
E_{\text{emissivity}, \Delta_i} = g(\theta_{\text{sensor}}, \Delta_{\text{object}}, T) E_{\text{sensor}, \Delta_i} L(\Delta_{\text{object}}, T)
\]

#### 3D Model

A target with 4 different materials properties

![3D Model Image]

- [a] Classical emissivity with 4 bands
- [b] Spectral emissivity for the target in the 7.5µm − 13µm bandwidth
- [c] Camera, target and environment in the visible
- [d] Temperature and emissivity retrieval

#### Results

### Conclusion and perspectives

**Conclusion:**
- Comparison of methods to estimate simultaneously emissivity and temperature
- Study and development of a 3D scene IRT simulator

**Perspectives:**
- Add measurement noises in the simulation process to observe their effect
- Combine temporal and spatial information in Bayesian methods for further improvements of joint estimation

### Bibliography


Authors wish to thanks Bretagne Region for its financial support.