Chapter 5
Infrared Thermography for Intelligent Robotic Systems in Research Industry Inspections: Thermography in Industry Processes

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ABSTRACT

Infrared thermography has been applied in different research projects involving leakages, micro-climate monitoring, energy control, security, and predictive maintenance. The chapter focuses on image and data process techniques improving intelligent inspection systems able to extract hidden information. Image segmentation techniques, data mining, and machine learning approaches have been applied by proposing innovative models suitable for accurate process monitoring. The proposed models can be adopted for the engineering of industry processes involving quality, production performance indicators, security systems, resources management, and intelligent scheduling of activities. Different networks able to transmit data and thermograms are described by discussing system integration in robotic systems. The proposed chapter provides elements and requirements for the design of infrared thermography facilities in industries. Different cases of study of industry projects have been analyzed in order to provide models usable in different application fields.

DOI: 10.4018/978-1-7998-0137-5.ch005

INTRODUCTION: SOME RESEARCH TOPICS REGARDING IR THERMOGRAPHY IN INDUSTRIES

Mechatronics and Robotics are of strong impact in engineering science oriented on innovative ways to synergize multiple disciplines and enhance machine intelligence (Habib, 2008). In particular mechatronics is interdisciplinary and opens new horizons in all field (Habib, 2007). An interesting field for mechatronics is thermography. Thermography is adopted in different industrial research fields. Regarding food and machines to preserve food quality, thermography has been adopted for food quality monitoring (Samanian et al., 2016), for the check of refrigerator thermal behaviour (Björk et al., 2010), and for the identification of thermal regions of food affected by induced mechanical injuries or cold injuries (Samanian et al., 2016). Concerning leakages checking, infrared –IR- thermography has been adopted for gas sensing (Rogalski et al., 2002), for building thermal leakage using data mining approaches (Galiano et al., 2016). Artificial neural network has been applied in literature for the defect classification in electric applications improving predictive maintenance for power substation equipment (Ullah et al., 2017), and K-means clustering algorithms has been implemented for thermal clustering in photovoltaic networks (Massaro et al., 2018). In agriculture thermal images provided important information about moisture stress conditions of plants (Banerjee et al., 2018), soil microwave treatment (Khan et al., 2018), and other agriculture parameters (Ishimwe et al., 2014). Also in manufacturing control processes thermography is adopted for motor monitoring (Manama et al., 2011), degradation assessment control (Zhao et al., 2015), and other real time monitoring manufacturing processes (Usamentiaga et al., 2014). All the mentioned works prove that infrared thermography (IRT) is an important tool for process monitoring and for quality process improvement according with ISO 9001: 2015 for different industry fields. Other aspects correlated with IRT inspections are:

- Worker security (controlling temperature of work environments machine and tolls);
- Crack detection in robotic systems (Ghidoni et al., 2015);
- Defect classification (Grys, 2018);
- Detection of the excessive friction due to improper lubrication or material fatigue (La Rosa et al., 2000);
- Robotic system for electrical distribution inspection in industry (Cheng et al. 2019);
- photovoltaic efficiency (Crișan et al., 2019);
- gas leakage (Yang et al., 2019);
- Night vision enhancement (Raghatate et al., 2013);
- Water building infiltration (Ljungberg, 1994);
- Visibility through smoke, light fog, snow, and rain in defence systems (Akula et al., 2011).

Many of the listed applications can be applied for specific cases of study involving industry monitoring processes, thus providing solution in energy efficiency, security, and production line predictive maintenance. A good implementation of the potential use of IRT is in robotic and automated systems oriented on the inspection time reduction and on the measurement optimization. In this scenario some authors used Unmanned Aerial Vehicle (UAVs) for photovoltaic control (Aghaei et al., 2014), building inspection protocols (Entrop et al., 2017), and vegetation monitoring (Sagan et al., 2019). UAVs has been applied also for surveillance applications involving image fusion between visual and thermal image enabling tracking monitoring (Kumar et al., 2011). In this direction in this chapter will be proposed some