

Preface

In general, one picture or one image conveys thousands of words. It would be easy to analyze and interpret image data for more information. Images are available in different modality based on the band of frequency used in spectrum for capturing it. Thermography is a technique in which thermal energy is used to measure heat emitted from an object. Thermography is also called as Infrared imaging in which surface temperature of objects are measured. This technology uses pseudo-color image processing to describe the temperature distribution of object surface with infrared temperature calibration. Infrared thermography cameras produce images of invisible infrared or heat radiation and provide precise non-contact temperature measurement capabilities. In real life, all the objects gets heated up before it fails to function, in these situations thermography based diagnostics tool could be used to avoid malfunctioning of devices or equipments. The measurement of heat helps us to carry out further analysis depending on the application for which it is applied.

Thermography technique could be used in many diverse applications because of its low cost. In industries it helps to improve product quality, work safety, efficiency by reducing failure rate of objects due to heat. In industrial environments thermal imaging is being used for finding hot-spots that can lead to failures in electrical and mechanical installations. Electrical cabinets and motor control centers are regularly scanned with a thermal imaging camera for temperature monitoring for early stage detection of anomalies to avoid disasters. On the other side, it plays a major role in military and defense department for detecting land mines, rescuing people from natural disasters. Thus, Infrared thermal imaging has been used extensively in military, industry and security applications. It is also used applications such as remote sensing, electrical, electronics, petrochemical, plant physiology, geology and medicine.

Thermal imaging devices could capture images with higher spatial resolution that leads to variety of engineering applications starting from the fundamental scientific researches to the development of advanced scientific researches. Similarly advancements in image processing techniques allow fast and accurate processing of

thermal images. By combining advancements in both thermal imaging techniques and image processing techniques, many real world problems in military and industrial domains could be addressed with less effort. Keeping this in mind, the objective of this edited book is to provide the researchers of various fields like computer science, electrical, electronics and Information Technology the recent advances and approaches of infrared thermography and its applications in industries. To achieve these objectives, theoretical background, advances and its applications to real time problems are emphasized. I believe, this effort can make this collection interesting and highly attractive to research community.

Many of the researchers in different organizations across the globe have been doing research in thermal image processing. To keep abreast with this development, it is an effort to bring the recent advances in thermal image processing and its applications in a cohesive manner. The main objective is to bring most of the major developments in the above mentioned area in a precise manner, so that it can serve as a handbook for many researchers. I trust and hope that this book will help the researchers, who have interest in Computational Intelligence in thermal image processing and its recent developments in industrial applications, to keep insight into recent advances and their importance in real life applications.

While these are a few examples of issues, my intention in editing this book is to offer concepts of Infrared Thermography and its applications in a precise and clear manner to the research community. Editing this book is an attempt to provide frontier advances and applications of Infrared Thermography. The conceptual basis required achieving in depth knowledge in the field of computer science, electronics, electrical and information technology will be stressed upon. All these motivated me towards Infrared Thermography and its applications.

This book comprises of three sections. First section broadly covers foundation and principles of computational intelligence and its applications in thermal image processing. The second section of the edited book discusses about thermal imaging in human health care and diagnosis system. Third section discusses about various industrial applications of thermal images. In addition it also discusses about various approaches to enhance quality of thermal images.

Analyzing thermal images to get meaningful information is a tedious task. Therefore, digital thermal image processing is considered as very essential research areas in the current scenario to analyze and interpret the same. There are many traditional approaches exists to carry out thermal image processing but to ensure automation in image processing the role computational intelligence is essential. Computational intelligence techniques have firmly established themselves as feasible alternate mathematical tools for more than a decade. They have been extensively employed

in many systems and application domains, especially in signal processing, automatic control, industrial and consumer electronics, robotics, finance, manufacturing systems, electric power systems, and power electronics. In Chapter 1, a fuzzy logic based approach is proposed for flu detection using thermal images. As a symptom of infection, the body temperature of a disease carrier is higher than normal people. The increased temperature in human body would be captured by thermal images and that would be helpful in detecting the flu. Authors have proposed system able to capture a thermogram of the human subject, detecting the eye region of the human subject, calculating the pixels values around the detected eye region, converted to temperature readings and further classified the subject's body temperature whether the subject satisfies a flu condition or not. It is proved that the proposed fuzzy logic based Viola Jones algorithm can trace out flu infectious personal from the input thermal images with high accuracy. In Chapter 2, authors have carried out a study on the brain tumor segmentation using Fuzzy C-means methods and compared results other approaches too. Image segmentation is a technique which divides an image into its constituent regions or objects. Segmentation continues till area of interest or the specified object of target is reached. In order to measure and compare the accuracy, authors have used Dice coefficient and Jaccard's measure. It is observed that fuzzy-c means approaches are performing well than traditional approaches. Chapter 3 gives insight into basics of intelligence components that are used predominantly in thermal image processing like Fuzzy logic, Probabilistic reasoning, Neural networks, Genetic algorithms, Fuzzy association rules etc. In medical field, for disease diagnosis fuzzy logic approach and neural network approach have been well proved.

In general images of different modality play a major role in medical diagnosis. Imaging system capture images in contact with human body that may lead to severe pain also human body may be exposed to radiation also. Thus to avoid human contact and radiation thermal imaging can be considered as complementary to other modality images in medical applications. Thermal imaging is a non-destructive, non-contact system. In Chapter 4, the main concept and different applications of thermal imaging in medical application is discussed in detail. In addition, elaborate studies in thermography have been carried out to justify that it can be considered as a complementary tool to detect breast diseases. In Chapter 5, application of iris features such as texture and geometric features are deployed for human health diagnosis. The texture features present in the human iris are extracted using the mathematical statistical measure which is used to specify the characteristics of the texture of an image using gray-level co-occurrence matrix. The iris and pupil are extracted and correlated to the compactness features of the circle. Based on the comparison the results, prediction of abnormalities in the iris texture take place and helps to identify the affected person.

By combining advancements in both thermal imaging techniques and image processing techniques, many real world problems in military, and industrial domains could be addressed with less effort. In addition, usage of thermal images in security application and its enhancement methods are presented in detail. Moreover, optical analysis of solar concentrator with an image process is presented, to improve thermal efficiency of the solar concentrator. In Chapter 6, various components of thermal imaging system and its application is presented in detail. Infrared thermal imaging (IRTI) can provide the temperature mapping without a physical contact with the object of interest from a reasonable distance. In general, typical IRTI system comprises of a thermal camera equipped with infrared detector, a signal processing unit and an image acquisition system, usually in the form of an embedded system. Such cameras are utilized for applications like fault detection, irrigation management, motion detection, etc. This chapter briefly introduces use of thermal imaging in medicine, agriculture, environment, smart home/cities and security applications. In Chapter 7, optical analysis of solar concentrator with image processing is presented in order to improve thermal efficiency of the solar concentrator. The optical efficiency of solar concentrators has a high impact on its thermal performance. Thus a system determining the geometrical accuracy of a solar concentrator system is necessary. Thermal image quality enhancement is often required for its interpretation with high accuracy. It can be carried out by filtering approaches and contrast adjustment process. In Chapter 8, three recent methodologies for multidimensional processing on sequences of thermographic images are presented. All three methods for image enhancement techniques are presented in detail, starting with its mathematical foundations, algorithmic procedures, advantages and limitations. In recent world, providing security right from a home, marketing area, financial sector, etc ... is a very challenging task. There are several ways to ensure security in real time; one among them is human identification with high accuracy through biometric data such as thumb impression and iris features. In Chapter 9, a new approach for personal authentication using finger knuckle geometric and texture feature measurement are used. In addition, the entire finger back region including proximal and distal phalanx of the finger knuckle surface also added for recognition. The geometric measures are derived through angular geometric and texture measures are derived through statistical-based texture analysis methods.

Because of continued effort, it is ensured to keep the book reader-friendly. By a problem-solving approach, researchers learn the material through real life examples that provide the motivation behind the concepts and its relation to the real world problems. I trust and hope that the book will help the readers to further carryout their research in different directions.

While writing, contributors have referred several books and journals, I take this opportunity to thank all those authors and publishers. In addition, I would like to thank VIT University, India for providing facilities to complete this project. I am extremely thankful to the editorial board, reviewers for their support during the process of evaluation. I extend my sincere thanks to the production team of IGI Global, USA for their support, encouragement and extending their full cooperation in successful completion of this edited book.

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