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# Application of Infrared Thermography in Sports Science

 Springer

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ISSN 1618-7210                      ISSN 2197-5647 (electronic)  
Biological and Medical Physics, Biomedical Engineering  
ISBN 978-3-319-47409-0            ISBN 978-3-319-47410-6 (eBook)  
DOI 10.1007/978-3-319-47410-6

Library of Congress Control Number: 2016953653

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Printed on acid-free paper

This Springer imprint is published by Springer Nature  
The registered company is Springer International Publishing AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

*Like an editor, this book is dedicated to all the authors of the different chapters who thanks to them, the book has been carried out.*

*More personally, to Rosa for her support and love during the edition and writing of the book, and to Marina for giving me strength and enthusiasm with her arrival.*

# Foreword

The use of thermography in sports may serve as an excellent example to illustrate the possibilities of the technological advances for application in the context of sports sciences. First known for its wide application in sciences like engineering and physics, thermal cameras are now more and more popular among sports scientists interested in better comprehend the exercise induced adaptations, which can lead to a new branch of application of thermography. At the same time, it shows us how challenging can be the use of new technologies, especially due to a lack of background of sports scientists to use thermography and to interpret the results. In a world where new knowledge is making available faster everyday, all those involved in sports science and medicine are requested to keep up to date, and it also depends on knowing methodological aspects of techniques used in the daily professional routine. Due to the increase in the interest of applying thermography, as shown in Chap. 1, literature was missing a book like this, in which we can follow a step-by-step guide since the basic background of thermography technique to the more complex applications of thermal measurements in the context of human motion.

Author's effort to keep the text clear and concise is recognized. Illustration and examples included in this book accomplished the goal of helping the proper understanding of the concepts included, and a relevant list of references may help the reader in finding further material to consult. At the same time that this book provides basic information for those not familiar with the thermography, more specific and complex aspects of the technique are discussed with examples that are useful to improve understanding of those who already have the thermography as part of their routine of work. The limitations and possibilities are clearly stated, which provide an unprecedented support for those who are currently using the technique, or plan to use it in the near future. These characteristics of the text ensure to the reader the necessary knowledge to identify the critical aspects necessary to the correct application of thermography in the study of human motion.

This book is organized into 12 chapters with each chapter beginning with an abstract and an introduction to the topic of discussion. Conclusion and perspectives are included, which help the reader to finish the reading with a clear idea of what

are the next steps that could be important to development of the topic. Among the 12 very attractive chapters, unique is Chap. 11 that includes discussion on equestrian sports, showing the importance of considering not only thermography in the human body, but also in the interaction of the humans with the environment and other animals. Common to all the chapters is the uniqueness of the images and data presented, which helps to fully understand the concepts and more importantly contributes to a very clear presentation of authors' ideas.

This book has the potential to assume a leading position in the scientific literature related to thermography and will be a valuable addition to libraries of those who perform research on the topic of thermography, engage in clinical practice related to exercise and sports medicine or are decided to start using thermography in their practice. Furthermore, it is hoped that the information presented in this book will motivate you to seek additional knowledge in the use of thermography.

Uruguaiiana, Brazil

Felipe P. Carpes, Ph.D.

# Preface

I remember my first experience using thermography. It was while working at the IBV (Institute of Biomechanics of Valencia). I was immersed in a R&D project about heating systems in sports clothing. One of my colleagues asked me to perform some thermal images for the report. The thermographic camera was quite big, like a video camera television. It was inside of a box and no one had used it, probably because no much researchers knew of its existence. I made the images, but I did not follow any protocol or really understand its camera operation. In my opinion, that first experience exemplifies the first experience that many people are having today in laboratories and research centres. It is true that the difference between today and my first experience is that now the cameras are more manageable, cheaper and better quality, and there are a greater number of studies in sports science. But in many cases, infrared thermography is coming to laboratories as a new instrument which is cheap and very interesting, and researchers begin to use it without having a significant knowledge in its methodology, in the physics of heat transfer and thermoregulation, or in the research studies performed in sports science to date. Therefore, many “first-timers” studies have clear errors in its design, methodology and interpretation. Probably, the easy use a priori of the infrared thermography camera is one of the main reasons of this problem. One of the objectives of this book is to be a guide for these first users of the infrared camera in sports science research centres, laboratories or sports centres.

After finishing my time at IBV, I started as a researcher at the University of Valencia. I was interested in a group that was beginning to conduct research about the applicability of the infrared thermography in sports science. This group was the Biophysics and Medical Physics Group of the Department of Physiology, led by professors Rosa Maria Cibrián and Rosario Salvador. On the other hand, I also decided to start working on the Research Group in Sport Biomechanics (GIBD) of the Department of Physical Education and Sports, led by professors Pedro Pérez-Soriano and Salvador Llana-Belloch. Thus, I began to conduct research using infrared thermography, first as a researcher within the Physiology M.Sc. programme, then as a staff researcher at funded projects and finally as a researcher within the Physiology Ph.D. programme. Some of the projects were biomechanical



studies, and I implemented the analysis of the skin temperature with infrared thermography to assess interesting topics for me. Many of these studies are presented in the various chapters of this book. In each of these studies, I learned more about human thermoregulation during exercise and about the possible applicability of infrared thermography in sports science. In each of these studies, I would think that I was committing fewer errors. I hope this book will accelerate the learning process of future researchers using infrared thermography in sports science.

The aims of this book are as follows: (1) to show the applicability of infrared thermography in sports science, (2) to update the reader about the current knowledge in the different fields of application and (3) to provide the basic knowledge for the use and interpretation of the thermographic results. I expect that this book should provide a primary source for new students in the use of infrared thermography in sports science and hopefully an update for those who have been involved for a long time. This book not only is focused on sports researcher, but also it can be valuable for the sports technician in the medical and sports centres. Therefore, the aim of this text is to afford the reader the basic knowledge and the last updates for understanding the application of infrared thermography in sports science.

New findings are published in the last years about the dynamics of the skin temperature during exercise, the applicability of infrared thermography in sports science or the methodology of the technique. These findings, discussed in this book, provide fresh understanding on how it is possible to use infrared thermography in sports science, how thermoregulation influences sports performance, how injuries affect skin temperature and how is possible to use the temperature to evaluate garments and sports equipment, among others.

This book is organized into 12 chapters. Chapter 1 is a historical introduction of the application of infrared thermography in sports science. Chapters 2 and 3 are focused on providing the basic background and methodological knowledge to use correctly infrared thermography. From Chaps. 4 to 11, each chapter is focused on one field of application of infrared thermography in sports science. The final chapter aims to discuss the issues and possible developments of infrared thermography in sport science, in order to facilitate the future R&D. Each chapter begins with an introduction to the topic of discussion and ending with the conclusions of the chapter. Additionally, each of these chapters contains methodological aspects related specifically to the topic of discussion. An effort has been made to keep the text as concise and clear as possible yet as comprehensive as necessary.

I hope that this text will be a valuable addition to libraries of those who use infrared thermography in their sports research or in their professional field. Furthermore, it is hoped that this book will be useful to improve and orientate future studies and therefore improve the scientist's knowledge.

# Acknowledgements

Firstly, thanks are given for the Spanish Ministry of Education, Culture and Sport, which funds the thermographic research of the editor presented in this book by a doctoral fellowship (FPU).

The authors of this book are grateful to the different editorials to provide the permission rights to show some of the figures published in their articles.

Thanks are also given for Prof. Felipe Carpes for his very kind opening words in this book.

Some acknowledgements are provided by the authors for some of the chapters:

Chapter 6. The authors of this work would like to express their gratitude to the participants in the authors' recent studies (Seixas et al. 2014 "A preliminary study on the relationship between energy expenditure and skin temperature in swimming"; Vardasca et al. 2015 "Thermographic evaluation of swimming techniques"), as without them it would not be possible and have spent their freely precious own time and goodwill. A kind word also for the other studies' co-authors: Tomojiro Gonjo, Ana Sofia Domingues, Filipa Barbosa, Eduardo Marques, Marcio Borgonovo-Santos and Ricardo Fernandes, who had given a precious aid in the research, which was fundamental for the area knowledge development.

Chapter 10. The authors are grateful to the Spanish Government, "Subdirección General de Proyectos de Investigación. Convocatoria Proyectos I+D 'Excelencia'. Subprograma de Generación de Conocimiento, 2013" (project DEP2013-48420-P) by supporting the research performed about the foot temperature by the authors. In addition, Irene Jimenez-Perez acknowledges the Spanish Ministry of Education, Culture and Sport, which supported her research by a doctoral fellowship (FPU).

Chapter 11. Figures 11.10 and 11.16 have been published in Soroko and Davies-Morel (2016) and are reproduced here with kind permission of CABI Publishers (UK). Highly deserved thanks go also to Andrzej Soroko for his graphic skills in preparing other thermograms for this publication.

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