Diagnosis and therapy with thermographic control

by A. DALLOZ-BOURGUIGNON
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T. gives a good knowledge of the peripheric blood circulation. A quite frequent diagnosis of the diseases of micro-circulation, as well as a repetitive control of subjective clinical results are possible. The way of using this means of control in the treatment of blood peripherical circulation diseases by mesotherapy (local multi-injections of medicinal products) is shown.

NEW BOOKS

«THE EVALUATION OF MEDICAL IMAGES»: by A. Ll Evans.

A concise introduction to the field of image assessment and its application to medical imaging systems. The text progresses from an account of the formation and physical properties of images to a discussion of how the diagnostic medical image conveys information beneficial to the health care of the patient. Techniques are described for the evaluation of images and the extraction of quantitative information from them, prior to a consideration of the overall efficacy of imaging systems. Efforts to measure a <<figure of merit>> for an imaging system are discussed, providing an insight into the difficulties of image assessment using physical criteria, coupled with a realisation that a diagnostic image is useful only if it alters the treatment of the patient.

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CUGAS (UNIVERSITY CENTRE FOR GREAT SCIENTIFIC APPARATUSES) MEETING

On October the 13th 1980, the official presentation of a new infra-red thermographic imager (Biomaticfirm) recently acquired by CUGAS (University Centre for Great Scienttfic Apparatuses) took place at the University of Padua; the Rector and many Specialists in thermography were present.

The function of CUGAS consists in acquiring and managing expensive Scientific Apparatuses in order to promote their use in many Institutes of different Faculties.

The aim of the Meeting was the illustration of the possibilities offered by this thermographic imager not only in Medical Thermography, but in other fields too.

Thepresence of many Specialists in Medicine, Engineering, Chemistry, Physics, Botany, and Agricolture, testified to the value of the CUGAS formula. Acta Thermographica ispleased to present the summaries of the Reports presented at this Meeting, hoping this will be the first of a series of similar Meetings; their aim is to improve the relations between contiguous but different fields of knowledge.

Thermal infra-red surveys in water pollution and plant pathology

by C. LECHI

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T., as a system of non-destructive control of surfaces, has an ever increasing range of applications. Radiometers, scanners and thermocameras are normally employed on space platforms, aircrafts and on ground observation devices: they all aim at gathering information about the thermal behaviour of the surfaces.

The multitemporal infra-red surveys of a surface allow to put forward hypotheses regarding the objects below the surface; it should be remembered that practically all observable surfaces, apart from atmosphere, are opaque in the thermal infra-red band, even if some of them are transparent to the visible light (glass, water, etc.).

1. Pollution control. In the case of large areas control, such as the discharge of a river into the sea, the aerial T. offers a description which could not be obtained in any other way; the derived thermal map furnishes at least 2 important pieces of information: a) the *shape and the extension of the discharge* which, in the case of a polluted discharge, provides information on transportation geometry and hence allows to establish the actual danger involved in its possible return to shore; b) the *distribution of the mixing fresh/salt water.* The knowledge of such a distribution is important because a pathogenic pollutant lost its noxiouness in a salty environement. It was recently evaluated from an aerial T. of a river discharge the upwelling velocity; furthermore a physical mathematical model was performed, the T. of which constituted the boundary conditions for the solution of the equations.

2. Plant pathology. In the field of plant pathology the use of thermocameras is particularly useful since the classic thermometric measurements on the leaves suffer strong limitations. The experiences, carried out on tobacco and bean plants with T.M.V. infection (Tobacco Mosaic Virus) show that the leaves artificially diseased are in general warmer (about 1°C) than the healthy ones. The aim of the research is to know the radiating power in the case of the diseased plants in order to quantify their anomalous metabolism.

To sum up, T. can today be used as a conCrete method of inquiry in various sectors: in every field, nevertheless, it is particularly important to pay special attention to the interpretation of the data gathered, an arduous and not always immediate task.

Application of the computerized thermography to heat transfer problems

by R. MONT1

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A new way of using T. systems has been proposed; it relies on the measurements of the surface temperature time derivative and its correlation with heat transfer processes which take place at/or beneath the surface of a solid or a liquid body. A number of applications of the «unsteady T.» were illustrated as follows:

1. Computation of the power of heat sources embedded in solid material-its applications to breast cancer diagnosis have been described.

2. Computation of tissue blood perfusion in peripheral districts of the limbs (e.g. fingers or toes).

3. Computation of heat transfer coefficient on 3 dimensional bodies exposed to forced or natural convection (e.g. aerodynamic heating); all these applications are based on 4 essential steps. a) *Proper modelling* of heat-transfer processes, which relates the quantities of interest (for the above indicated 3 cases): a) the *heat source power*; β) the *blood perfusion* and, γ) the *heat transfer coefficient* with time evolution of the surface temperature map. b) *Numerical tests,* which provide the necessary support for ascertaining the feasibility of the experimental methods and which enable to define the proper parameters, theoretically significant and operationally measurable. c) *Data acquisition by a computerized T. system* which is able to furnish, at a given time, the temperature map as function of time T (w, y, t) ‘in the form of digital matrices T (i, j), taken at ‘different times. d) *Data elaboration by a computer* which performs the proper mathematical treatment of the matrices T (i, j) and extracts a number of parameters which are correlated to the quantities to be found. The work has been performed by properly interfacing a commercially available thermograph whith a microcomputer. A display on TV color monitor demonstrated the main features of the measuring systems.

Medical applications of thermography

by C. DI MAGGIO

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The areas of application of T. are numerous, since T. is able to detect every heat producing process.

The common belief that T. i[illegible]ly useful in the diagnosis of superficial tumours is wrong, since the range of its real informative capacity is much wider.

Thus, the staging of the tumour, therapy and prognosis are greatly advantaged.

Apart from its positive role in tumoural pathology, T. is also useful in physiology; in the latter field it can act as an useful means of experimental research (i.e. in the study of the efficacy of anti-inflammatory and vasodilator drugs, and of their best way of administration).

Useful information is offered by T. in the study of arterial and venous circulation, in rheumatology, in traumatology, in plastic surgery and in medicine of work.

The principle and the basis of infra-red thermography

by A. DOSSENA

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The basis for infra-red T. rests upon the principle that every object in nature emits energy in the form of electromagnetic radiation. The energy emitted by a surface is always less than that emitted by a << black body>>; i.e. the emissivity of a surface is less than a unity. The spectral distribution of a black body like radiator, is given by **PLANCK'S** function:

$$W(\varepsilon, \lambda, T) = \varepsilon C_1 \lambda^{-5} \{[\exp (C_2/\lambda T)] -1\}^{-1}$$

where ε = emissivity;

$C_1 = 3.74 \times 10^{-12}$ watt-cm^2;

$C_2 = 1.44$ cm - degree;

λ = wavelength in cm;

T = Temperature in K.

The total radiated energy per unit area over the complete spectrum (E) is given by the STEFAN-BOLTZMAN **law**:

$$E = \varepsilon \sigma T^4$$

where ε = emissivity; σ = STEFAN-BOLTZMAN constant; T = absolute temperature of the surface

The equipment used to measure the infra-red radiation from surfaces is an infra-red scanning system. The thermograph is. a scanning radiometer which scans a limited field of view and intercepts the infra-red radiation representing the temperature of the scanned object. The infra-red radiation is converted, through an infra-red detector, into an electronic signal and after electronic processing is ultimately displayed on the screen of an oscilloscope which is then photographed with a camera to produce a T.T. is a heat map which bears a resemblance to the visible image of the object but in which the intensity distribution represents the temperature distribution of the object. T. makes an instantaneous, noncontact temperature mapping possible. It is non invasive and totally safe. For these reasons T. is used in many fields in industry and medicine. In order to achieve a more objective interpretation of T. a computer assisted approach has been carried out for the determination of the temperature pattern.

In the development of new applications, the selection of the detector is fundamental (InSb or HgCdTe). In fact, the sensibility per unit area changes with the variation of temperature, in a different way for the 2 detectors. Under 200°C the HgCdTe detector is more sensitive; over 200°C the InSb is more valid. A second possibility concerns the resolution of the **T.** image, strictly related with the number of images per times units.

One may select an image of 30.00 points with 16 frames per s or an image of 300.000 points with l/2 frame per s; of course the resolution is very different.

The choice between the different possibilities depends on the sensitivity in this field, of the researchers.