

MOIRE TECHNIQUE IN MEDICAL DIAGNOSIS AND CONTROL OF REHABILITATION

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Comission V

1. Introduction

This paper is not meant as a presentation of the theoretical bases of the moire topography because they have been discussed in detail in numerous other publications [1], [4], [5], [6].

The method of analysis of the moire topography depends on the equipment and requirements of a medical center which uses this technique. Generally, there are two ways of recording the moire pattern depicted on an object with the use of a regular or TV camera. Accordingly, there are two different approaches to the problem of analyzing the moire topography: traditional a graphic analysis of a photo of an object with the moire contourgraph and a computer processing of the television image.

The latter, in which both the recording of the picture and its processing are fully automated seems to be best predestined for a widespread use. However, there are countries where photogrammetric methods are hardly popular in medicine if their use is in an initial stage, then it would be difficult to introduce sophisticated systems. More rapidly adopted for appraising rehabilitation results or for diagnostic purposes in many medical centers can be simple and cheap methods.

In this paper will be presented a few typical examples of an application of the moire technique in solving different medical problems. Most of the experiments were carried out by the Institute of Photogrammetry and Cartography of the Warsaw Technical University on commission from the Factory Clinic of the Ursus Mechanical Works.

2. Examples of the application of the moire technique

In the examples under consideration, the moire contourgraph were recorded with a camera. The screen with lines from 0.5 to 2 mm thick /depending on the needs of an experiment/ was placed in a special device which also fixed the patient. In other words, in comparative studies it secured a repeatability of the patient's location in relation to the projecting-photographic system. Two symmetrically situated light sources were used for lighting. The space between contour lines was determined either analytically - according to the conception presented in [6], or with the use of a wedge. The following studies were made:

a/ determination of changes in the spine resulting from locomotor rehabilitation /fig. 1 a,b/ and to apply electrostimulation to relax muscles and relive pain /fig. 2 a,b/.

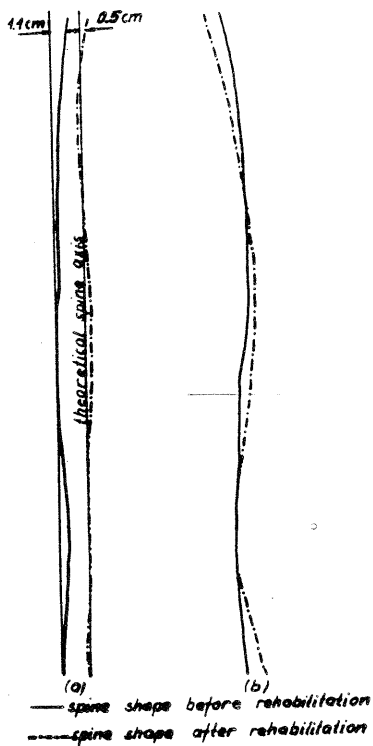


Fig. 1
Presentation of spine
shape changes
a/ frontal plane
b/ sagittal plane

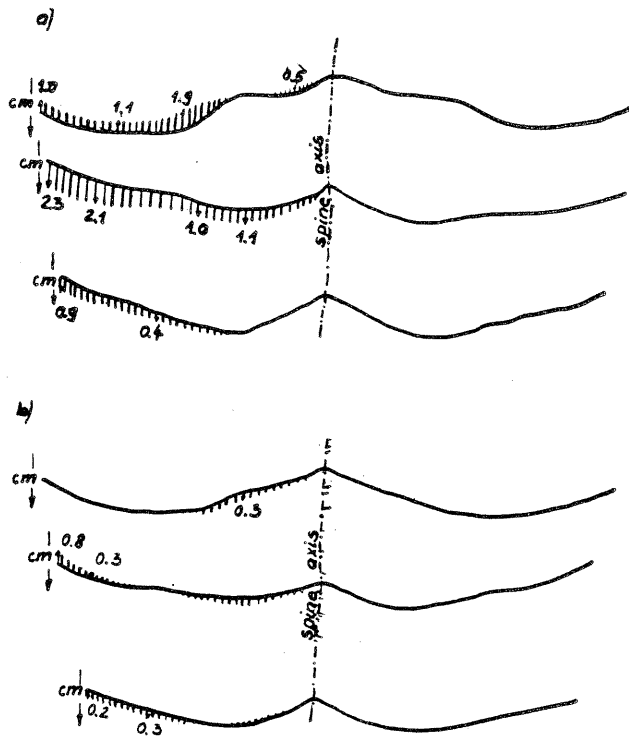


Fig. 2
Asymetry of shape of back thora-
cic - lumbar portion
a/ before rehabilitation
b/ after rehabilitation

Figures 1a and 2a show the shape of the spinal column in a frontal view /XY/ while figures 1b and 2b depict the same shape in a side view /YZ/. The unbroken line stands for the shape of the spine before the rehabilitation, the dotted line - afterwards. In both cases, the measurement pointed to beneficial results of the rehabilitation.

b/ to define changes in the muscle-bone system in the vicinity of the spine following a chemotherapeutical and rehabilitation treatment. Figures 3a,b depict a reduced asymmetry of the back before and after electrostimulation.

c/ to make a diagnosis in the examination of the shape of the foot to determine the flat-foot. To assess irregularities, a series of photos of the sole - under load and without - has to be made. The foot without load can be photographed directly, while in the case of the foot under load it is advisable to make a photo of its cast. Figures 4a,b show a longitudinal and cross-section of the foot under and without load.

d/ to define a capacity of each of the lungs separately. Spirometric methods are useful to define only a total capacity of the lungs, but are useless to determine the contribution of the left and the right lung separately. This task boils down to defining a capacity of the lungs, that is, to making a series of photographs of the chest and the back in the inspiration and expiration phase. Naturally, the realization of this task is much more complicated than the previous ones

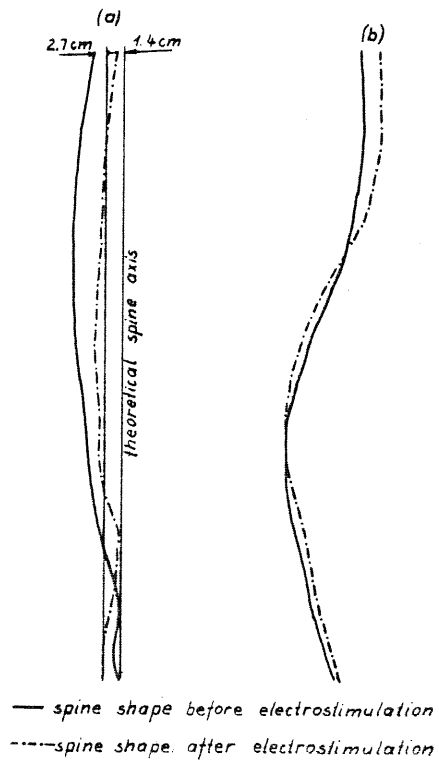


Fig. 3
The changes of spine shape on thoracic - lumber portion under
of electrostimulation effect
a/ frontal plane
b/ sagittal plane

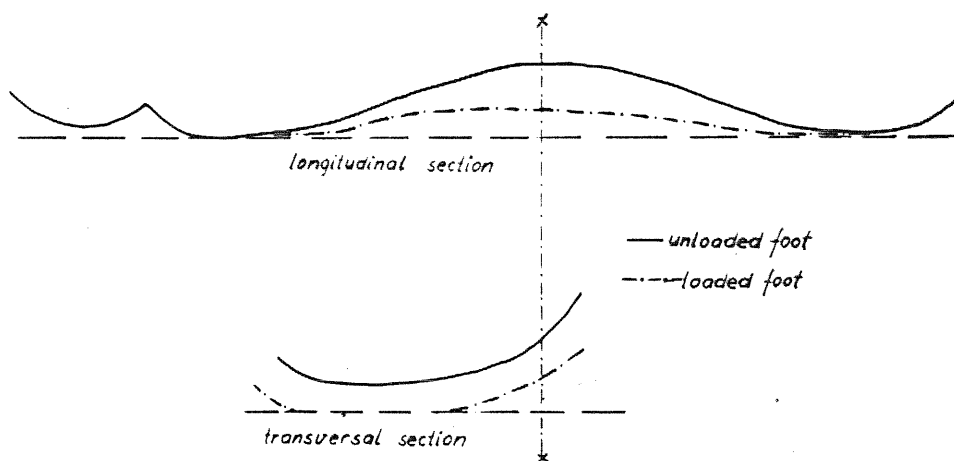


Fig. 4
Deformation of fornix of foot under the influence of load

because of:

- the need to combine the front and the back part of the body which requires a proper signalling of the object and a measuring of the distance between corresponding points on both surfaces;

- the need to make a laborious defining of the capacity which in turn requires calculations relating to the partial surfaces limited by the two successive contours of the moire pattern with a simultaneous consideration given to differentiated scales.

Results achieved with the use of the moire technique are convergent - with a few percent tolerance - to those obtained with the use of the spirometric method. The main advantage of the moire technique in this case is that it allows to define the share of each lung in the respiration process - a possibility offered by no other non-invasive method. A study of the respiration mechanism provides the information on the contribution of the particular parts of the chest to the respiration process which is of prime importance in case of ailments affecting this part of the body. It also allows to assess effects of the respiratory rehabilitation.

The results obtained in the course of studies conducted on three patients are depicted in tab. 1.

Tab. 1

Patient number	Capacity of both lungs cm ³		Difference %	Capacity of each lung			
	Spirometric method	moire technique		left		right	
				cm ³	%	cm ³	%
A	3600	3339	7.5	1511	45.3	1828	53.9
B	5900	5825	1.3	2361	40.5	3464	59.5
C	3850	4114	6.8	1897	46.1	2217	53.9

Notice: Patients A and B are considered healthy, Patient B - sick

e/ to define the shape of the spine for diagnostic purposes. Application of the moire technique under consideration in this paper is currently used by a team of the Institute of Photogrammetry and Cartography in a major experiment consisting in establishing the shape of the spines of some 800 students from a Warsaw high school. The results of the measurements, which are analyzed by a physician participating in the experiment, will serve to assess spine defects in this particular age group. This in turn will allow to formulate prophylactic recommendations and correction exercises, and will also become a basis for defining proper work posts for these youths in the future. An example of processing this experiment is shown in fig. 5a,b,c /the graphic presentation

of the shape of the spine in planes XY, YZ and XZ /.

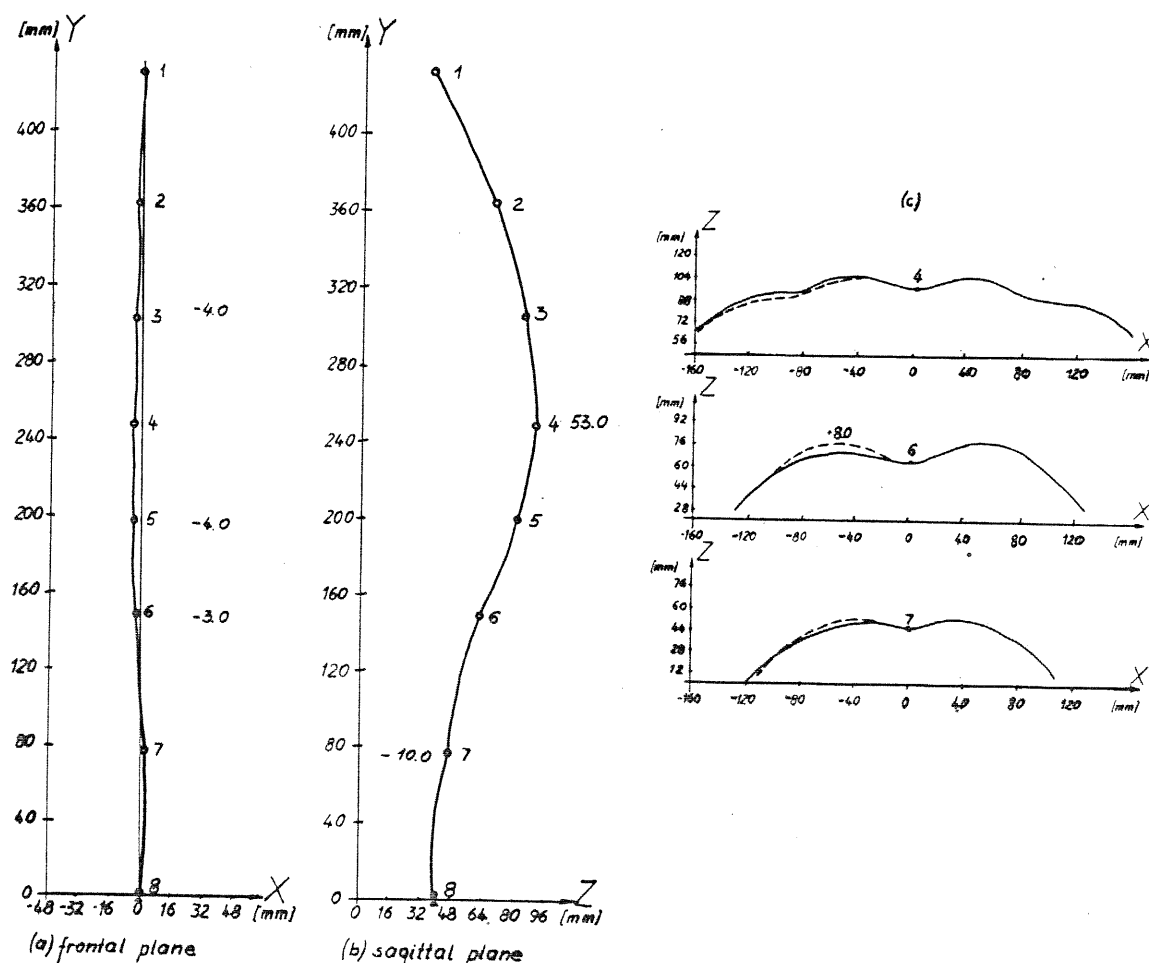


Fig. 5

The changes of spine shape on thoracic - lumbar portion

a frontal plane

b sigittal plane

c asymetry of shape pf back on thoracic - lumbar portion

The additional data which help a physician assess the state of the spines and postures of the patients are:

- the distance separating the particular segments of the spine from the line linking the highest /"1"/ and the lowest /"8"/ vertebrae /in Plane XY/
- the maximal distance between the thoracic region of the spinal column and the right 1-8 line, and in the lumbar region - from the right 4-8 line
- data characterizing the asymmetry of the muscle and bone system often resulting from spinal defects.

The last example discussed concerns an experiment designed to compare the results of a measurement of one region of the spine with the use of the moire technique to those obtained with the use of stereocroentgenography [2]. The differences between results obtained with the two methods did not exceed ± 1 mm. The experiment has demonstrated that in many cases of

diagnostics and rehabilitation control X-ray photographs can be substituted with the moire method - non-invasive, simple in nature and easy to applicate.

3. Conclusions

Summing up, it can be said that judging by the studies conducted in various photogrammetric centers in the world, including Poland, the moire technique is a useful method in the examining and solving of medical problems. Obviously enough, depending on the popularity of photogrammetry in medicine and financial possibilities, this technique can either be fully automated or applied with the use of fairly inexpensive conventional photographic equipment.

Thanks to the research program which has been pursued for several years by the Institute of Photogrammetry and Cartography of the Warsaw Technical University and concerning application of photogrammetry in medicine, a photogrammetric laboratory was recently established at the Factory Clinic of the Ursus Mechanical Works in Warsaw in which most of the experiments discussed in this paper have been conducted. The above-mentioned measuring projects will be continued in this laboratory in relation to large population groups affected by various factors of the labor environment.

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