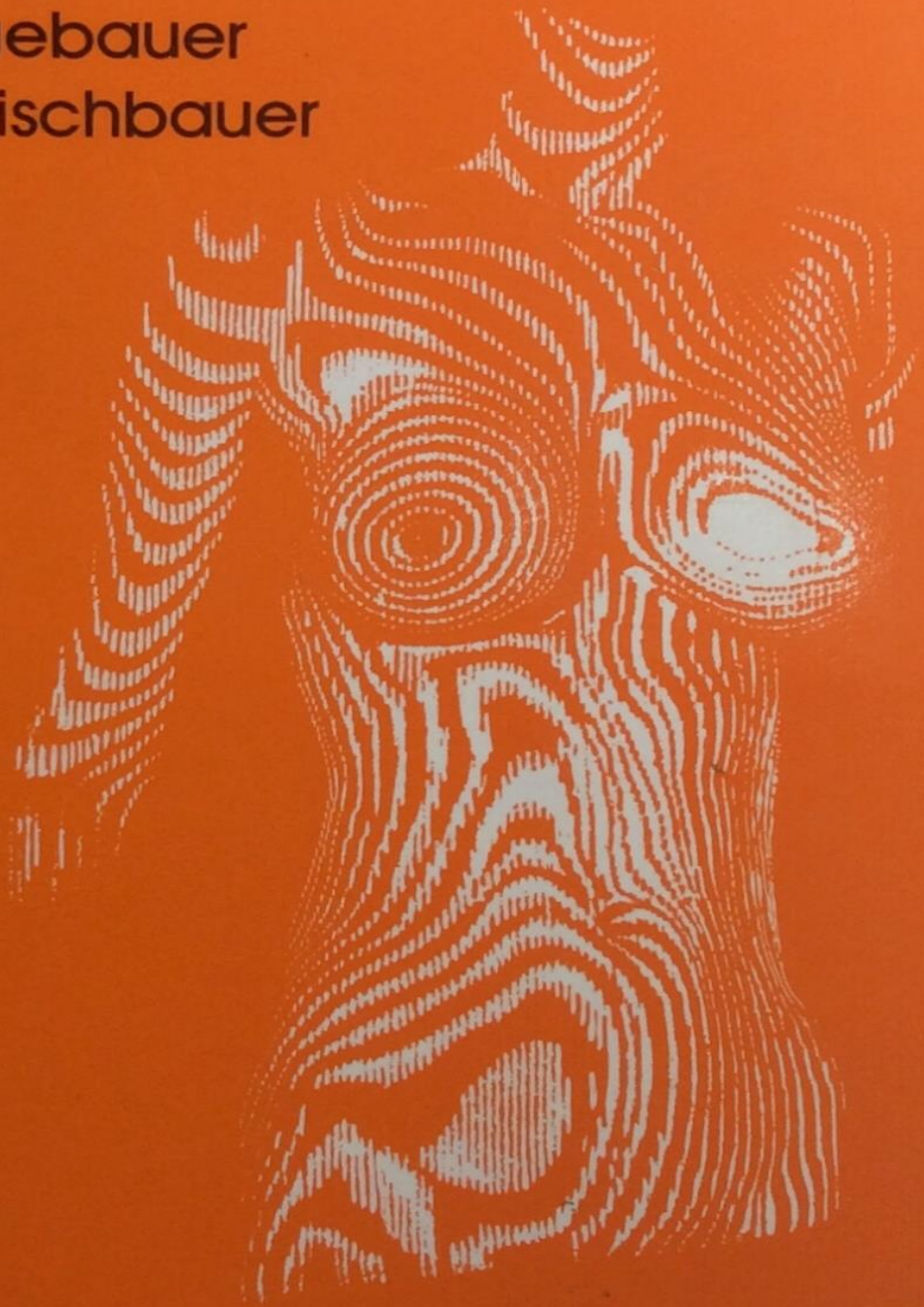
Surface Topography and Body Deformity

Edited by
H. Neugebauer
G. Windischbauer



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Reproducibility of moiré topographs

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Abstract

This paper examines the issues regarding the reproducibility of moiré topographs and outlines the need for an objective criterion for reproducibility. A criterion is proposed to obtain reproducible moiré pictures. An experiment is designed to test this criterion.

1. Introduction

Moiré fringe topography has proved to be extremely useful in the diagnosis and documentation of scoliosis. It is also being applied in the evaluation of anterior chest wall deformity. The power of this technique lies in the fact that it is simple, inexpensive, noninvasive and does not use any ionizing radiation. In addition the technique provides a map of three-dimensional surfaces by generating contours which are curves of constant height. Unlike contouring with holographic techniques, stability is not required. In addition, the resolution of moiré contouring systems can be varied continuously.

The technique of moiré topography consists of photographing the part of the body to be studied through a specially constructed screen. Dark fringes are produced on the body because of the presence of the screen. The study of these fringes gives valuable information about skeletal deformities.

2. Description of the problem

Moiré topography is being applied in the evaluation of spinal deformities for more than eight years. Adair, van Wijk and Armstrong (1977) felt that the few positive cases in their pilot screening program for scoliosis, which were missed by the moiré technique were due to the fact that some children were not properly aligned or had to be rotated by the shoulders to obtain the required orientation. Moiré technique is also being applied for the follow-up of scoliosis patients. If the moiré topographs are to be compared at subsequent intervals, then there must be some reference point. Shochat and Csongradi (1983) used moiré technique in the evaluation of anterior chest wall deformity. They placed the patient behind the screen facing the camera with the abdomen in contact with the screen. This technique provided a central fringe which was used as a reference point. However, during therapy and surgery for pigeon chest the shape of the abdomen is not guarantied to be the same as the initial one. Hence this technique is not reliable. There is another consideration when positioning of the patient is done for the study of posture and spinal deformities. If one tries to obtain any type of reproducible position, one is immediately distorting the condition one is trying to examine, particularly if one tries to rotate the trunk on the pelvis. Even the positioning of feet tends to rotate one hip to a mild degree as observed in small curves.

During recent years there has been considerable concern over the accuracy and repeatability of moiré topographs (Csongradi, Jefferson, Turner-Smith and Harris, 1987; Bannon and Tredwell, 1987; Jones, Scull, Dutton, White, Slinger and O'Connor, 1987).

3. Attempts to position the patient and the moiré apparatus

My group used a special lamp and scale arrangement to position the patients in some of the earlier studies (Kamal, 1982). Two laser beams were used to align the patient vertically and horizontally. A mirror was attached to the patient's sides using two plastic strips. The proce-

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(3a) $S_\psi = [\text{Sum}\ (\psi_j - \langle\psi\rangle)^2/(N-1)]^{1/2}$

(3b) $S_\chi = [\text{Sum}\ (\chi_j - \langle\chi\rangle)^2/(N-1)]^{1/2}$

The maximum of these deviations is then recorded

(4) $S = \max(S_\psi, S_\chi)$

The method proposed will be considered reliable if $S < 0.05$. In order to find a standard for reproducibility on moiré topograph avoiding the area being studied, it is proposed that symmetric fringes on the knees be considered as reference provided the patient does not have any leg deformity. In many cases of skeletal deformities, however, this is not the case. If the fists of the hands are taken as reference, they will be relatively independent of the skeleton. However, since the fists can be rotated easily, a standard plane is needed. Fig. 2 shows a pair of stands which the child can hold in his palms and thus fixing the position of fists. This positioning will not significantly effect the posture. The child will be asked to stand relaxed looking straight ahead on some fixed point on the wall. Symmetric fringes on the front and back sides of the fists can be used for positioning the camera for the study of chest as well as back.

5. Materials and methods

A shadow moiré apparatus is being used to conduct the study. The specifications of the moiré set up are described elsewhere (Kamal et al. 1988). For the criterion to have statistical validity hundred normal healthy boys of class seven are requested to participate in the photographing process. The children are marked on the back using a skin marker and photographed with their shoes and stockings off as recommended by Free (1974). Two photographs of the back are taken by the same person to determine the reliability of the procedure. The angles are measured on all the photographs. In the end factor S will be calculated.

6. Conclusion and discussion

If the factor S comes out to be less than 0.05, the criterion could be applicable. Further work in reproducibility could be done to study the stability based on fist as well as knee positioning for front photographs. Objectivity studies could also be done for both fist and knee positioning to compare the results of different observers.

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[v] Full text: https://www.ngds-ku.org/Papers/C18.pdf

[£] Full text: https://www.ngds-ku.org/Papers/C17.pdf

[∀] Full text: https://www.ngds-ku.org/Papers/C33.pdf

Spinal deformities, especially scoliosis, are a severe problem of the young people. The challenge is to prevent surgical intervention by non-invasive screening programs for early diagnosis, to follow-up the effects of treatment and to predict the course of scoliosis. Optical, acoustical and mechanical techniques have been developed to meet this challenge and to minimize the risk of frequent X-raying. Since 1980 an international group of clinicians, engineers and scientists has met bi-anually to share techniques, results and data on body surface shape and spinal deformities. Digital image processing is providing better means for the three-dimensional description and visualization of the human body. Therefore contributions on surgical planning, implant shaping and reconstructive surgery are included to represent the current state of 3D-medical imaging and visualization in this book.

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