Moiré Fringe Topography to Detect Scoliosis in Children

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As we learnt from the article "How to guard against curvatures of spinal column in children?" (The "News", March 8, 1997), scoliosis, lateral curvature of the spinal column, effects children in their growth period with girls affected 5 times more than the boys. The deformity may disfigure the body; damage vital organs and may require major spinal surgery involving delicate nerves. If recognized early, the deformity may be arrested by a combination of exercises and braces.

It is not possible to X ray all children for the purpose of detection of spinal deformities, because the heavy doses of X rays required for spinal imaging of children are harmful for their developing bodies (Fig. 1). We are, therefore, in need of methods which are inexpensive, easy to implement, simple to be performed by moderately trained personnel and elegant enough to permit handling by various algorithms without exposing children to X rays.

The need to find a convenient three-dimensional-measuring system led to the development of photogrammetry in the middle nineteenth century. Medical photogrammetry is the term used to cover all applications of photogrammetry in the broad field of medicine. These include strerophotogrammetry, holography, integrated-surface-imaging system (ISIS), 3-D-video-laser-scanning system, rastersterography and moiré fringe topography.

Fig. 1. AP X ray (standing, external-auditory meatus to hip joint) of spine of a 10-year old with positive forward-bending test

Fig. 2 *a-d*. Moiré topographs of the same child during a follow-up examination (back, front, side, forward bending)

Moiré fringe topography is an inexpensive, simple, noninvasive, noncontact optical imaging technique, which provides a three-dimensional map of the object or subject under study. It is being used in more than a dozen countries for the diagnosis, the documentation, the follow-up and the quantification of scoliosis (Fig. 2).

When a family of curves is superposed on another family of curves a new family appears ——— the moiré pattern. To produce the effect the overlapping lines should intersect at an angle of less than forty-five degrees. Moiré systems are of three types: basic form of moiré topography or shadow type, projection type, grating-hologram type. In simple words, the basic form of moiré fringe topography consists of photographing part of the body, to be studied, through a specially constructed screen. Dark fringes are produced on the body because of the presence of screen. If the light source and the camera both lay along a line parallel to the plane of the moiré screen the fringes on the human body are contours of constant distance from the screen.

Ordinary X rays provide two-dimensional information. There is, also, a risk of developing cancer from over exposure by X rays. Moiré techniques provide three-dimensional information, without the involvement of ionizing radiations. Hence, these techniques pose no risk to the children being examined. Further, these techniques do not cause any pain or discomfort to the child. There is a need to establish annual moiré screenings of spinal column of the school-going children as is being done in Japan and Sweden.

Our group developed, locally, shadow (capable of taking full-body pictures of children up to the age of 10 years) and grating-hologram type moiré systems. In addition, three-dimensional static and dynamic models (the static model to be used to study posture

——— the way a person stands or sits; the dynamic model to study gait ——— the way a person walks or runs) of the human spinal column have been formulated. It is, now, possible to generate a picture of the spinal column in three dimensions from moiré topograph of back of a child. Moiré contours have been combined with edge-based algorithm (http://www.ngds-ku.org/Papers/J17.pdf) to study gait of children. The backscatter-moiré of the spinal column (proposed on May 30, 2013 by the Project Director) seems to have the potential of going one step ahead in scoliosis management (http://www.ngds-ku.org/Presentations/Backscatter.pdf).

In the next article we shall see what we can learn by observing gait of children.

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