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学位論文題目	(医用　モアレ　トポグラフィ) MOIRE TOPOGRAPHY FOR MEDICAL USE
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論　文　内　容　の　要　旨

In 1970, the application of the optical moiré effect was initiated by two papers, which were published by Professor Hiroshi Takasaki and Meadows et.al. The greatest contribution came from Takasaki, and it is my personal view that the "pretty picture of live body" of Takasaki's object contributed a lot to the success of moiré topography in medicine.

The moiré topography in its standard form was a known technique when I entered the field, but the problem associated with its application to a medical objects were not solved yet. The serious problem is that we can not identify concavity and convexity of the portion of an object where contour moiré fringes are close loops. Identification of concavity and convexity by moiré topography is urgently needed by doctors when dealing with abnormally-shaped bodies to which a priori knowledge of normal body cannot be applied. This thesis studies and developes various techniques of moiré topography for medical use, where measurement of human body shape is required. It explores new methods and establishes new concepts applicable to moiré topography.

First, conventional moiré techniques are reviewed and directionality of moiré fringes formed by the Windischbauer type three-dimensional grating is studied analytically and experimentally. Windischbauer proposed the new technique in 1979, which gave directional intensity profile of the contour moiré fringes depending on whether the slope of the surface was ascending or descending. Directional moire fringes means a type of moiré fringes which gives directional intensity profile to the moiré fringes showing the contour line. According to Windischbauer type grating an illumination angle of 45° and an observation of −45° was required to obtain directional fringes after averaging the fine structure. It means that directional fringes can be obtained only for large angles of separation between illumination and observation, which limits the practical application of the Windischbauer type grating.

Based on the study of the Windischbauer type grating, I proposed a new type of directional grating. The structure of the grating used in this method is composed of one thread and three threads in different layers, called one-and-three-thread type grating. Intensity profile of the fringes obtained by the one-and-three-thread method is analytically predicted by a simple graphical method. Adequacy of the design of the one-and-three-thread grating for a given condition was demonstrated experimentally. Distinct directional fringes are obtained by illuminating the object with only 5°, and observing the object from a direction perpendicular to the grating, which is desirable in clinical application of this technique.

In addition, I proposed and developed a new technique, called Two-Frequency Moiré Topography, which renders information on the concavity and convexity of the surface as well as the contour moiré fringes. This technique also readily gives the absolute order of a fringe directly from a photograph, from which one identify the concavity and convexity of local curvature. This technique is suitable for collecting date of unknown shape such as a deformed human body without ambiguity. Another technique, called Square Grid Projection Method, is also proposed for the three dimensional shape measurement. This technique is a straighforward method which determines the three coordinate values of the points selected on a test object. In this technique, the grating of the so-called shadow projection type moiré topography is replaced by a grid forming 2—3 cm square mesh. By this technique, we can obtain the three coordinate of the intersection point of the grid,using almost the same formula of moiré topography. Because we can obtain three coordinate for each intersection point, we can determine the convexity and the concavity without referring to apriori knowledge.

From the effort various techniques of moiré topography for measurement of human body

shape have been developed. Several examples of the field application are demonstrated, such as scoliosis and the effect of treatment of the funnel chest deformities.

From the results of the study described, the following conclusions can be drawn :

(I) I borrowed a technique proposed by Windischbauer and developed a technique to predict the intensity profile of the fringes obtained. Based on the study of the Windischbauer type grating, I proposed a new type of the grating, called one-and-three-thread type grating. Directional contour moiré fringes have been obtained with small angle of the illumination and observation by using the one-and-three-thread type grating.

(II) The determination of the absolute fringe order required for quantitative measurements by moiré topography and the identification of the concavity and convexity are made easy by using Two-Frequency Moiré Topography.

(III) By using Square Grid Projection Method, we can determine the concavity and convexity without referring to apriori knowledge.

(IV) The results from the three methods are the same, but the one-and-three-thread method is more convenient than the other methods, because it shows all the information of the whole body photography, so it needs not to do the experiment for many times.

The three methods introduced all satisfy the conditions of the optical arrangement of the shadow projection type moiré topography; namely the use of a geometrical shadow rather than the use of the image of grid formed by a lens, and the observation at a distance from the grating exactly the same as that of the light source. Further development of these methods by a computorized system using electronic imaging device will be an interesting future work.