LINE-LASER SURFACE SCANNING MACHINE PLANNING FOR THE 3D APPAREL INDUSTRY

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Summary

The Department of Polymer Engineering of Budapest University of Technology and Economics (BUTE) and, along with the researchers of Laboratory of Informatics of the Faculty of Mechanical Engineering have been working in the development of a 3D designing system for the apparel industry. In this article we introduce the 3D surface scanning machine. This machine is suitable for investigation of dimensions of the human body and the behavior of textile drapery. According to this method the surface is illuminated by horizontal, thin beam of light and that is photographed. Both of the camera and the laser moves vertically step by step. It can deduce the properties of the surface from the distortion of the line of the light. In this article we are presenting the machine structure, the alternative possibilities and limits of the examination.

1 INTRODUCTION

At BUTE the researchers have been working on the development of 3D modeling systems for the apparel industry since 1983. For the specially constructed 3D virtual spectacle view and the 2D made-to-measure pattern designing are necessary the dimensions of the human body and the mechanical attribute of using textile. Our aim is to create a new method, which we can use for the designing of made-to-measure patterns and for the building-up of the 3D body model. Main point of the project is the construction of the surface scanning device.

2 THE SURFACE SCANNING MACHINE

2.1 Applied principle

Optics provides the most modern methods for scanning surfaces. The real advantage of these measuring is a touch-free technology. It means the measured object is not burdened by measuring-pressure. We applied principles for surface scanning which are based on a well-known and often-used method, called light-cutting. For example it can be applied to exanimate the roughness of the surface of metals (eg.: car body) [1]. The angle of incidence of the light and the view was 45° but nowadays there are also experiments for other angles.

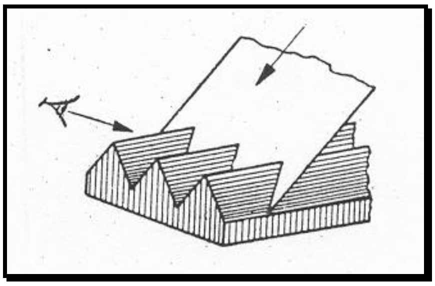

Fig.1. Scheme of light cutting[2]

In our planned machine the light-line falls horizontally on the examined surface. The camera, which is turned with about 30°, takes the photos. The light-line is moving on the surface vertically step by step while the camera is moving synchronic with that. This method allows us to get pictures of horizontal segment of the examined surface.

For 3D surface construction, the curves, which were got during the process, must be put one on top of the others. This way a wire-net is created which makes us able to stretch a surface on it. Movement of the optical unit is generated with appropriate accuracy by a stepping-motor. This motor lets the unit scan continuously or step by step, if required. The thickness of projected line is about 3-4 mm. Smaller or same stepping distance is unnecessary. 10-15mm steps are adequate in apparel industry that makes the time of examination shorter and decreases the member of photos.

2.2 Pictures wheeling and dealing

In the computer saved, crude photos will be modificated significantly. First of all, the distortion of the pictures must be corrected, which are due to the shadows, the covering and perspective. This is a considerable problem if the model extends toward the camera. The measured dimension is smaller than real (Figure 2.). Moreover, pictures must be modified to give back correctly the cross-section of the examined model.

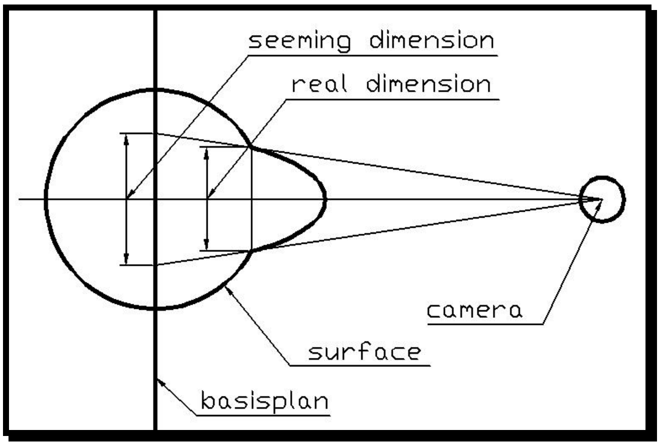

Fig.2. The mistake of the perspective

On right side of Fig. 3 X' represents the seeming distance; X is the real distance line from the basis plan. The line must be stretched in vertical direction of to get the spline of the surface [3]. The extent of stretching depends on the angle between camera and source of light (α).

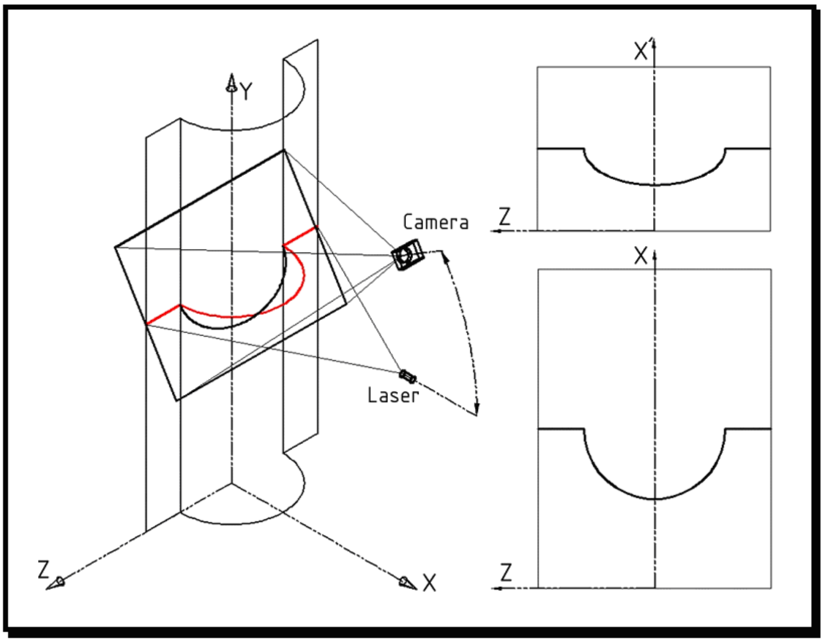

Fig.3. The applied method of the light cutting

$$\frac{X}{X'} = \frac{1}{\sin \alpha} \tag{1}$$

2.3 Measuring circumstances

The circumstances of the measuring are based on the development. In the room minimum 5m*5m free space is needed to set up the machine. The total dark room isn’t important but the bright room should be avoided, either. The laser projects a strong, well-visible, and good contrast light. The examined surface or person doesn’t need special wainscoting or clothing. A sole impression shows the good position of the model for the measurement of the human body. Against moving of the upper part of the body, to stabilize the position of the arm the machine has a handhold, which standing out from the floor. During the measurement the examinated person must stands in the machine with motionless body and closed eyes. This task is practically impossible on the long run therefore the period of examination is maximum 30 sec.

2.4 The planed construction of the machine

The machine contains basically two parts. The task of the framework will be to move the optical unit, and give appropriate stiffness and good dismantlement. The possibility of horizontal settings must be provided. The resources are aluminum profiles, because it performs the expected properties well. In the optical unit the position of the laser diode, lean angle of the camera, and distance of between diode and camera must be adjustable.

As shown in the Figure 4, threaded spindle generates the vertical moving. The spindle is revolved by stepping motor and very good accurate is due to it because the motor turns 1.8° per steps. Two V-belts are responsible for the connection between the motor and the spindle. The carriage moves up or down on the spindle it depends on the spindle turns right or left.

The step motor has maximal frequency. If threaded spindle is not rapid enough it will have to be exchanged with an other threaded spindle with bigger diameter.
Two important parts of the optical unit are the web camera and the line-laser diode. The camera should have a suitable breadth horizontal visual angle (~70-80°), resolution corresponding to television (eg.: 640*480 pixel), good sensitivity (min. 2 lux). The laser-diode must give a good light in the well visible domain, the thickness of the projected line must be smaller than 3 mm, and the wide-angle of the projected view must be minimum 70°.

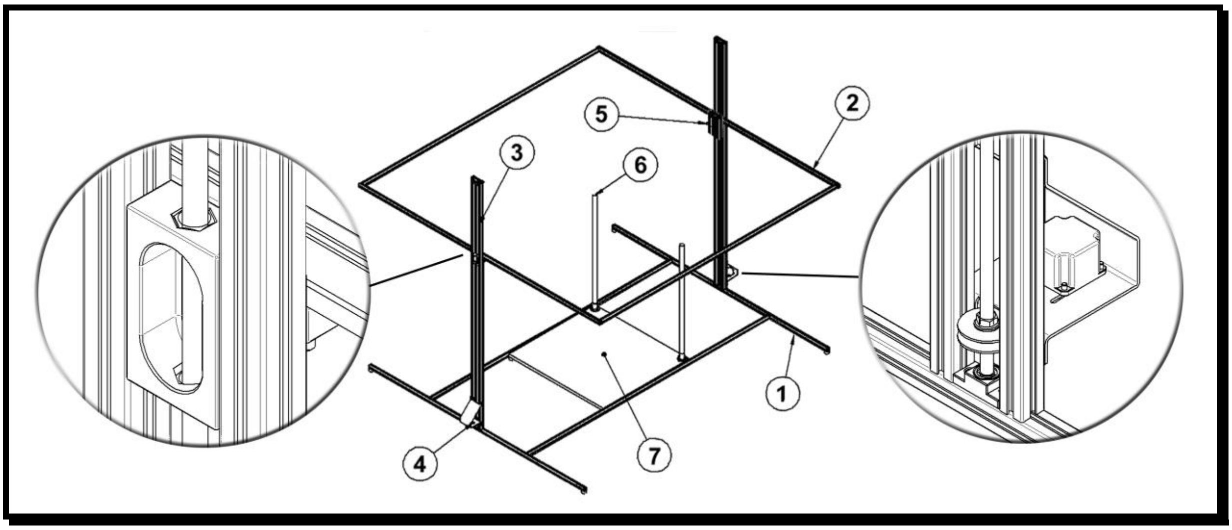

Fig.4. The model of the 3D measuring machine
(1. Standing framework, 2. Moving frame, 3. Directing turret, 4. Stepping motor, 5. Optical unit, 6. Handhold, 7. Platform)

2.5 Computer program

A special developed program on PC controls the machine and makes us able to process the pictures. The task of picture processing module of the software is to do the above-mentioned wheeling and dealings on the pictures, to filter light stains, which occur during photographing, without lose substantial data. Moreover, it makes contour descriptive curves from the original pictures and builds up the 3D surface from these curves in scale. The software saves the results in such a format which other programs can also use.

2.6 Practical experience

Before we built up the prototype we had tested the method with a plank-model. For the long time test-measuring we needed a motionless model which was a store-model in this situation. The plank-model and the result of the measuring is shown in Fig. 5.

After the examination we checked the accuracy of the measuring that is good to suitable for apparel use [4]. We chose the breast-contour, the waist-contour and the hip-contour. We made a comparison between the hand-measured and the computer-measured. The tolerance of the results was within 5 percent.

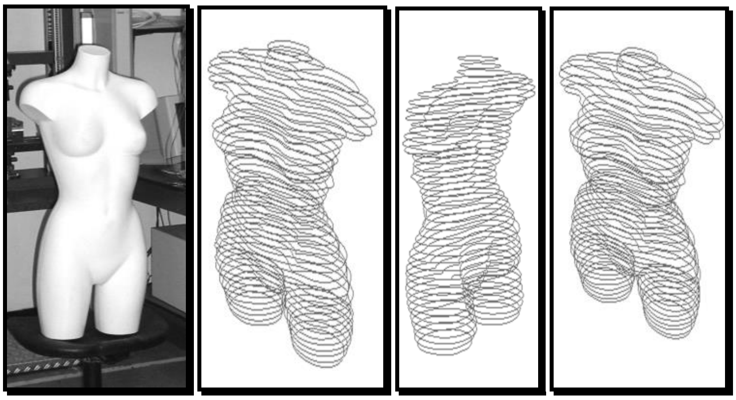

Fig.5. The plank-model and the result of the measuring

3 CONCLUSION

In this article we presented the 3D line-laser surface scanning machine, principles of the method, the construction of the machine and the results of the measurements. The machine can be used to measure the properties of the human body, to examine the physical properties of textile materials, and the pleating of the worn cloth. The creation of the machine is in progress now, so there aren't concrete experiences at measurements. Research tests are really encouraging.

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