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FEATURES OF OBTAINING AND PROCESSING DATA FOR INFORMATION ON THE FORM OF CROSS WINDING

ОСОБЕННОСТИ ПОЛУЧЕНИЯ И ОБРАБОТКИ ДАННЫХ ДЛЯ ИНФОРМАЦИИ О ФОРМЕ КРЕСТОВОЙ НАМОТКИ

M. N. NURIEV

М. Н. НУРИЕВ

(Azerbaijan State Economic University UNEC)

(Азербайджанский государственный экономический университет UNEC)

E-mail: mehman62@mail.ru

The questions of obtaining initial data on the shape of cross-winding textile packages are considered.

It has been established that geometric properties are characterized by a number of indicators, which in its turn can be subdivided into nominal and deviations from nominal ones.

Deviations of these parameters from the specified values lead to a loss of pack quality. The winding conditions become worse. The packages are not triggered at the same time during warping, which leads to the necessity of using additional winding equipment for the rewinding of residues and more frequent changing of packages with decreasing winding density and volume.

To obtain primary data on the shape of the package, it is proposed to use the shadow projection method in combination with automated pattern recognition tools. To analyze the shape of the winding in the process of its formation, it is proposed to obtain primary images in the form of video clips. Primary data is processed using the original software. The paper describes the structure of the algorithms underlying the present software. The developed processing algorithm involves splitting the video image into separate frames. It also involves conversion to a black-and-white palette, filtering, reading the edge coordinates of the bobbin image, scaling, and building a 3D image of the package.

An algorithm has been created that allows the online processing of data on the shape of packages. This builds 3D models of real packages in the process of their winding. Comparison of the obtained models with the exemplary ones allows for identifying the causes of defects, as well as violations of the technological process that cause them. The information obtained in this way allows for optimizing the process of cross-winding package production in textile production.

Рассмотрены вопросы получения исходных данных о форме текстильных паковок крестовой намотки. Установлено, что геометрические свойства характеризуются рядом показателей, которые в свою очередь можно подразделить на номинальные и отклонения от номинальных.

Отклонения указанных параметров от заданных значений приводят к потере качества паковки. Ухудшаются условия сматывания. Паковки при сновании срабатываются неодновременно, что приводит к необходимости использовать дополнительное мотальное оборудование для перемотки остатков и более частой смене паковок при снижении плотности намотки и уменьшении их объема.

Для получения данных о форме паковки предложено использовать метод теневой проекции, а для анализа формы намотки в процессе ее формирования – изображения в виде видеороликов. Обработка первичных данных производится с помощью средств автоматизированного распознавания образов и оригинального программного обеспечения. В статье описана структура алгоритмов, положенных в основу настоящего программного обеспечения. Разработанный алгоритм обработки предполагает разбивку видеоизображения на отдельные кадры, преобразование к черно-белой палитре, фильтрацию, считывание координат края изображения бобины, масштабирование и построение 3D-изображения паковки.

Создан алгоритм, позволяющий в режиме on-line обрабатывать данные о форме паковок, строить 3D-модели реальных паковок в процессе их наматывания. Сравнение полученных моделей с образцовыми позволяет выявить причины возникновения брака, а также нарушения технологического процесса, которые их вызывают. Полученные таким образом сведения позволяют оптимизировать процесс получения паковок крестовой намотки в текстильном производстве.

Keywords: packing, shadow projection, image filtering, image recognition, recognition algorithm, shape deviations, quality indicators.

Ключевые слова: паковка, теневая проекция, фильтрация изображения, распознавание образа, алгоритм распознавания, отклонения формы, показатели качества.

Introduction

The use of instruments makes it possible to determine the presence and count the number of defects of a certain type on the yarn, as well as to assign the yarn under examination to a certain purity class. The final result must be an assessment of the suitability of the examined yarn for the production of a particular fabric or knitted fabric. When using instruments and methods, such a judgment must be made by the technologist on the basis of his/her experience. The use of computer analysis with pattern recognition methods allows this task to be automated to a greater or lesser extent.

Traditionally, optical methods are used to control surface micro roughness in mechanical engineering. The two most common methods are light section and shadow projection.

In contrast to methods using surface scanning, the shadow projection method does not require a long time to capture the primary image. In this regard, the combination of the shadow projection method with modern means of automated pattern recognition seems to be the most promising. It allows to create a system of three-dimensional modeling of a textile package on the basis of experimental data. Such a model can be used for complex estimation of geometrical parameters of textile packages.

The most promising method for obtaining such images is the method of shadow projection in combination with means of automated pattern recognition. The implementation of this method is based on the use of a device for obtaining a shadow projection image, a device for the registration of this image and its digitization. In its turn, the latter requires special software designed to recognize the image of the package in the image and build a three-dimensional model of the package. Let's consider the solution to the listed number of questions.

In this connection, conducting research aimed at the development of an algorithm for obtaining initial data and their processing to obtain information on the shape of textile packages of cross winding seems to be relevant.

Using the device [1], images of shadow projections on the side and end surfaces of the cross-winding bobbins are captured and recorded with a digital camera. In the process of imaging, the bobbin is rotated, which allows for obtaining data about the entire outer surface of the bobbin. The resulting data is stored in the computer's memory. These video clips contain fairly complete information about the actual shape of the bobbin. After appropriate processing, they can be used to obtain a three-dimensional visual model of the package [2] and quantitative assessments of various defects.

An enlarged scheme of the algorithm for obtaining initial data and their processing to obtain a visual model and quality indicators characterizing the bobbin shape is shown in fig. 1.

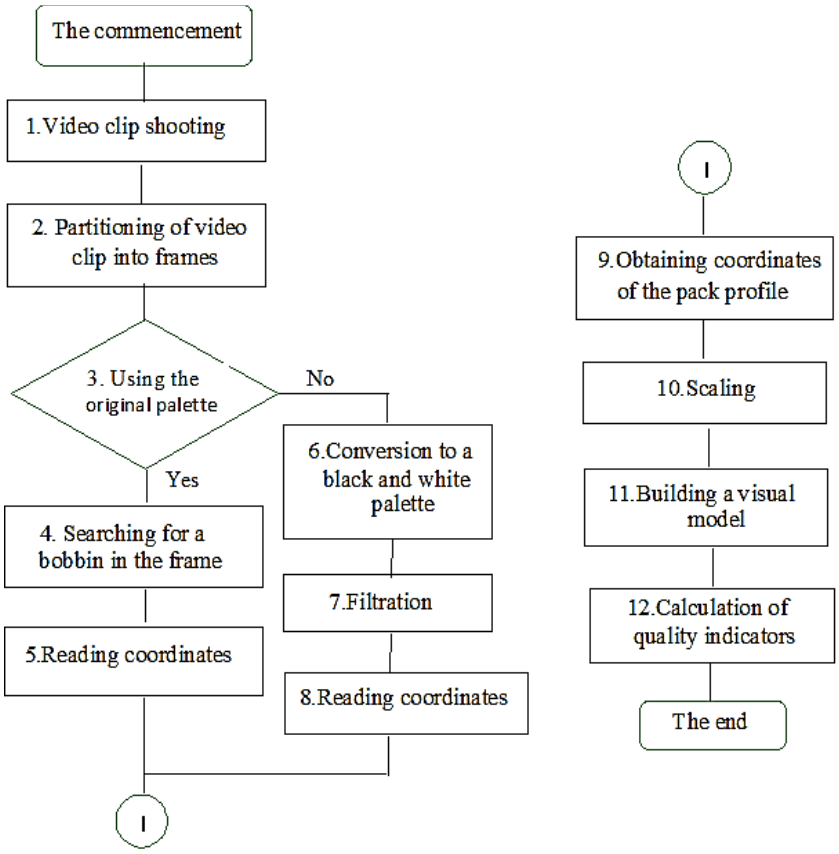

Fig. 1

The implementation of operations that make up the content of block 1 is described in detail in [1]. Let's consider the contents of the other blocks in detail. Partitioning of video clips into frames. The primary information received by the hardware-software complex are video clips shot using a digital camera. The clips are recorded in QuickTime format with the MOV extension, which is defined by digital camera software. This format is a standard for working with video images in the MacOS family of operating systems on Macintosh computers [3].

This format cannot be played back on Windows as a standard. To do so, you must install a set of specialized QuickTime libraries. There are at least two ways to solve this problem. The first is to convert the MOV format to a format supported by Windows, i.e. avi.

The second involves the use of a special library, QTMLClient.dll [4, 5], containing a set of functions. Functions from this library allow you to work directly with the frames of a MOV format video clip. For example, the OpenMovieFile function opens a MOV file directly, and MCGetControllerBoundsRect reads data about the video clip borders.

When analyzing the possibilities of using the first approach, it was found that there is a sufficient number of software products for conversion from one format to another [6 8]. However, all of them work via GUI (Graphical User Interface) and do not allow you to perform conversions from the command line in batch mode. This limitation is unacceptable because the speed of video clips processing will be significantly reduced due to the fact that the user will have to "manually" convert all video clips and only then perform the procedure of their storyboarding. However, the most significant disadvantage of all format converters is the loss of the original data during conversion.

The second method is more complicated to implement, but it relieves the user of such a chore as converting each clip from mov format to avi format via GUI. In this method, the format conversion is handled by the specialized library qtmlClient.dll from QuickTime.

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Thus, [9] proposes an optical system for yarn defect evaluation on the bundle. In this system, the primary image was acquired using a video microscope and transferred to a personal computer for processing.

In [10], the influence of the quality of yarn package preparation for weaving was analyzed. It is shown that the final quality of products of textile production depends significantly on the quality of the bobbins. Irregularities in the bobbin shape are often the cause of uneven yarn tension, which leads to instability of the technological process.

In [11], a yarn quality control system on packages is described as a basis for quality assurance of finished products. An image processing method is used in this study to evaluate yarn defects. Initially, images were taken using a scanner, and then the acquired images were modified using several filters. Yarn defects were then identified based on their geometric shape and surface area. As the results show, image processing methods are quite reliable at estimating the number and type of yarn defects.

Materials and methods

At the initial stage of development, it was suggested to save each frame obtained as a result of video clip splitting in a separate bmp format file on the hard disc and then process the resulting set of files. As practice has shown, this method requires a lot of space on the hard disc when processing a large number of video clips. Besides, the process of writing into and reading from the hard disc is a much slower operation compared to accessing the RAM. And because frame processing requires multiple accesses to data storage, the processing process can be unacceptably slow. This process can be performed much faster due to the fact that each frame received with the help of a function from the QTMLclient.dll library is loaded into the computer's RAM and processed directly there. This method is applied in the developed software. It allowed us to increase the speed of execution of the storyboarding procedure several times. Algorithms of the storyboarding procedure are shown in fig. 2 (recording to memory are shown) and fig. 3 (recording on a hard disc).

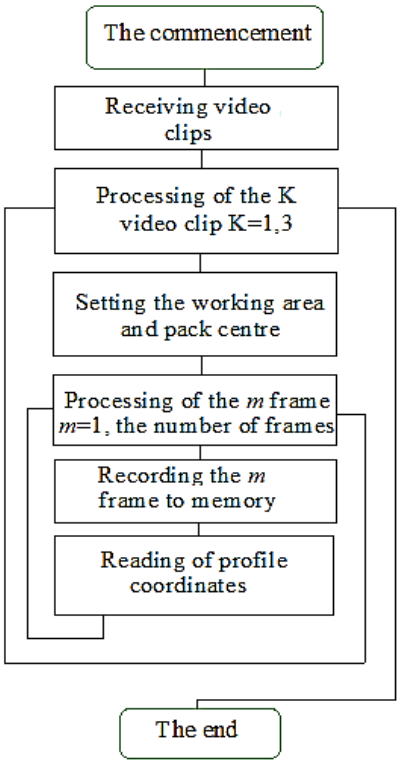

Fig. 2

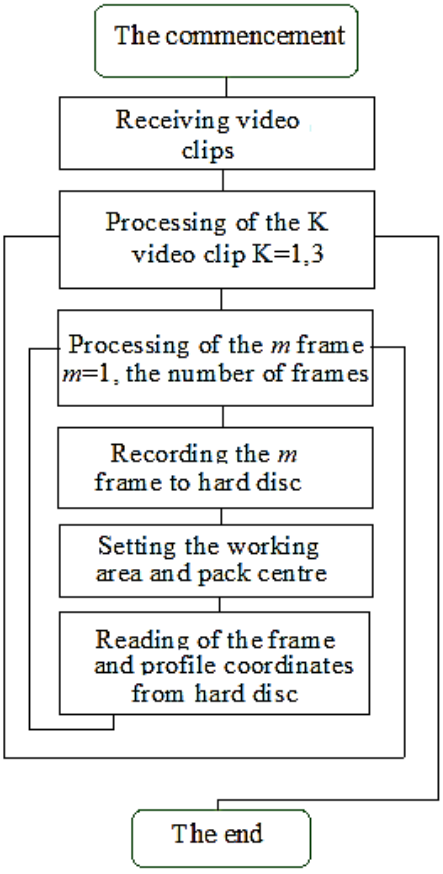

Fig. 3

Results and discussion

The pack profile coordinates can be obtained in two ways. The algorithm for video clip splitting into frames is shown in Fig. 1: blocks 6–7-8, or 4-5.

The first of them was applied at the initial stage of development. It consists of the following operations. After dividing the video clip into frames, an initial image of the profile of the side or end surface of the package is obtained (fig. 4). On it, the package is represented by some set of colors lighter than the background colors. At the border of the package profile, there is a smooth transition from the package colors to the background colors.

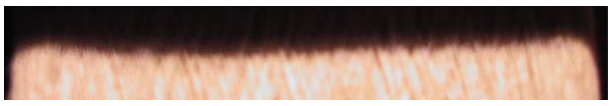

Fig. 4

The source image is converted to a black and white palette (Fig. 5). For this purpose, a threshold value is set in the software, which was obtained experimentally based on the processing of a batch of packages. This threshold can be changed by the user in the settings. In this case, on the contour boundary, there is a number of points of black color on a white background and white color on a black background. These points can complicate the unambiguous determination of the profile coordinates during subsequent processing. Besides, the frame includes the background image, which should be minimized to reduce the volume of files storing the intermediate image and to exclude unnecessary image elements, which require additional time for processing.

Fig. 5

In this case, it was assumed that the package profile image is located in the center of the frame with predetermined fields. That is, the significant area of the image was set statically.

After selecting a significant area of the frame, the image was filtered. This consisted of changing the color to a contrasting one for black areas surrounded by white areas and for white areas surrounded by black areas. The area of the processed region was limited to a square of three by three pixels.

The image of the lateral surface profile of the package after filtration is shown in Fig. 6.

Fig. 6

Then the reading of profile coordinates was performed. It consisted in consecutive interrogation of the color of image points vertically, starting from the top point belonging to the background and having a black color. The first point having white color is considered to belong to the package profile. Its coordinates are multiplied by scaling factors that take into account the scale of transformation, optical and digital magnification of the recording camera. They are entered into an array storing information about the shape of the profile of the lat-

eral surface of the package. The results obtained can be illustrated by the graph shown in Fig. 7. The Z axis on the graph is directed along the bobbin axis, and the Y axis is directed along the bobbin radius.

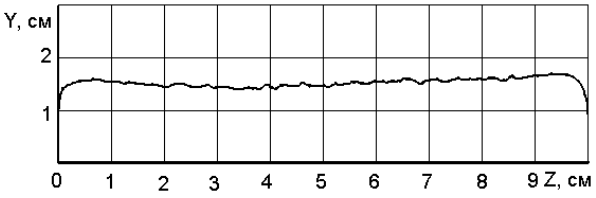

Fig. 7

In addition, the frame includes a background image. This image must be minimized to reduce the size of files storing the intermediate image and eliminate unnecessary image elements that require additional processing time.

When developing the algorithm, it was assumed that the image of the package profile is located in the center of the frame with preliminarily known fields, i.e. the significant area of the image was set statically. In practice, the frame boundaries were set by the operator.

Images of the package end surfaces were processed in a similar way. The obtained data can be used to calculate unit indices characterizing the deviation of the package shape from the specified one. On their basis, it is also possible to detect shape defects and build a three-dimensional visual model of packing.

When processing spools made of viscose complex yarn, it was revealed that the material reflects well the incoming light. In this connection, it is practically impossible to register the real package profile when processing the obtained video image. In order to obtain the real profile of the package, it is necessary to use special polarizing and fluorescent filters. As shown in the study, yarn coloring does not prevent package shape analysis by the shadow projection method.

In the development of new spinning and winding machines, the application of the proposed method is even broader. This is because, in a newly developed design, the number of controllable design parameters is many times greater than in series production machines. Each of them must be set in such a way as to ensure the formation of packs of the required quality, both in terms of shape and other technological parameters.

Conclusions

1. On the basis of the analysis of exist

ing solutions, the choice of a rational method of transformation of primary information about the pack profile into a format convenient for its further processing has been made.

2. Algorithms for processing video clips containing primary data on the bobbin shape and obtaining arrays of coordinates of points characterizing the bobbin shape on their basis are developed.

3. An algorithm for obtaining a volumetric graphical model of the package on the basis of arrays of coordinates of points characterizing the bobbin shape is developed.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this article and the published research results, including the financial aspects of conducting the research, obtaining and utilizing its results, and any non-financial personal relationships.

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