Vision system for monitoring process of winding cylindrical products with a carbon bundle

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Abstract. The problem of control of a correct laying of carbon bundle on a mandrel is considered. A mandrel in the form of a cylindrical pipe is considered in the article. Software has been developed for automated analysis of controlled parameters (distances between points). The results obtained are preliminary and can be improved by: optimizing the camera position and lighting; taking into account camera distortion parameters; formation of a development of the surface of the sharpening with bundles.

The problem of control the correct laying of the carbon bundle on the mandrel when winding the pipe [1-2] can be solved by using a visual control tool based on machine vision technology [3-5].

The scheme of intermediate control of the manufacture of a single-layer pipe made of carbon fiber is shown below in Figure 1:

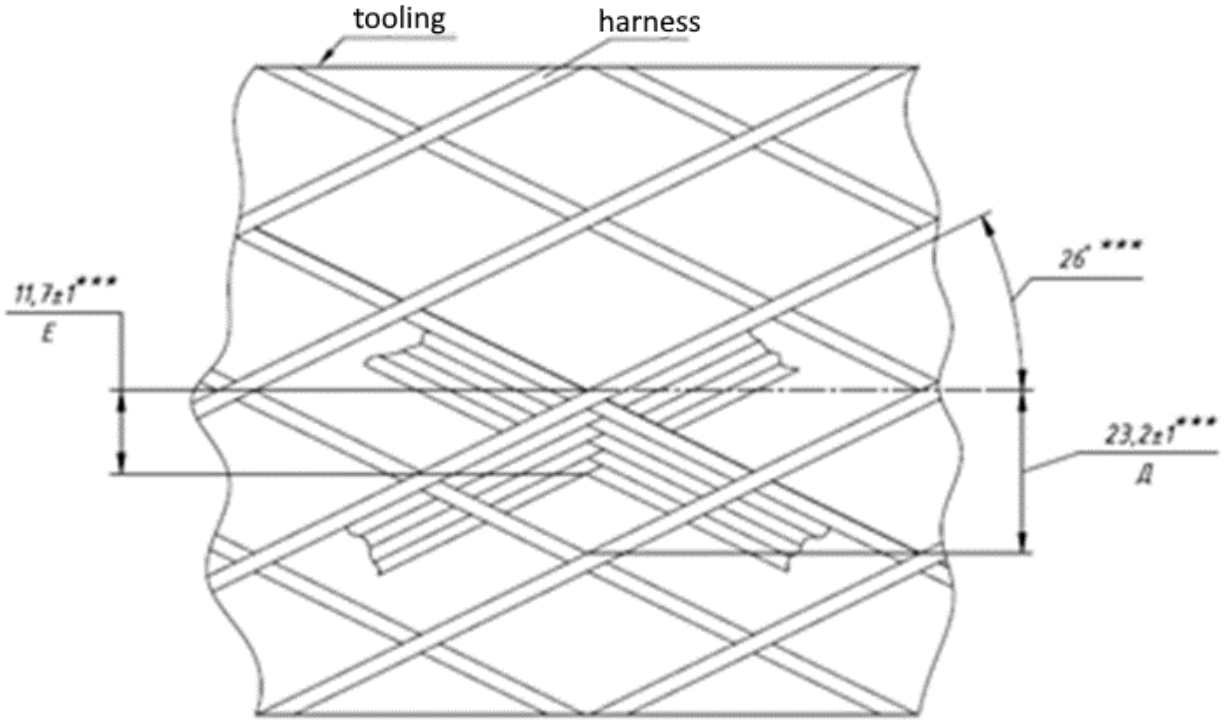


Figure 1. Scheme of intermediate control of the manufacture of a single-layer pipe made from carbon fiber

The proposed intermediate control algorithm is based on the analysis of differences in the color spectra of the harness and tooling. As a result of the analysis, the obtained areas are interpolated with the selection of key points. The distance between the points is calculated along the chord, taking into account the known diameter of the tool.

$$\alpha = \operatorname{asin}\left(\frac{y}{r}\right)$$

$$h = 2r \cdot sin(|\alpha_1 - \alpha_2| \,/\, 2)$$

where, α_1, α_2- is an angular coordinate of the key point; r - tooling radius; y - key point coordinate in Cartesian coordinate system.

The initial data are presented in color photographs in jpg format with a resolution of 5184x3456, the pixel width corresponds to a distance of 0.068 mm (the camera position is fixed relative to the tooling axis). The error in determining the key points in the current conditions is estimated at +/- 0.6 mm (+/- 8 pixels).

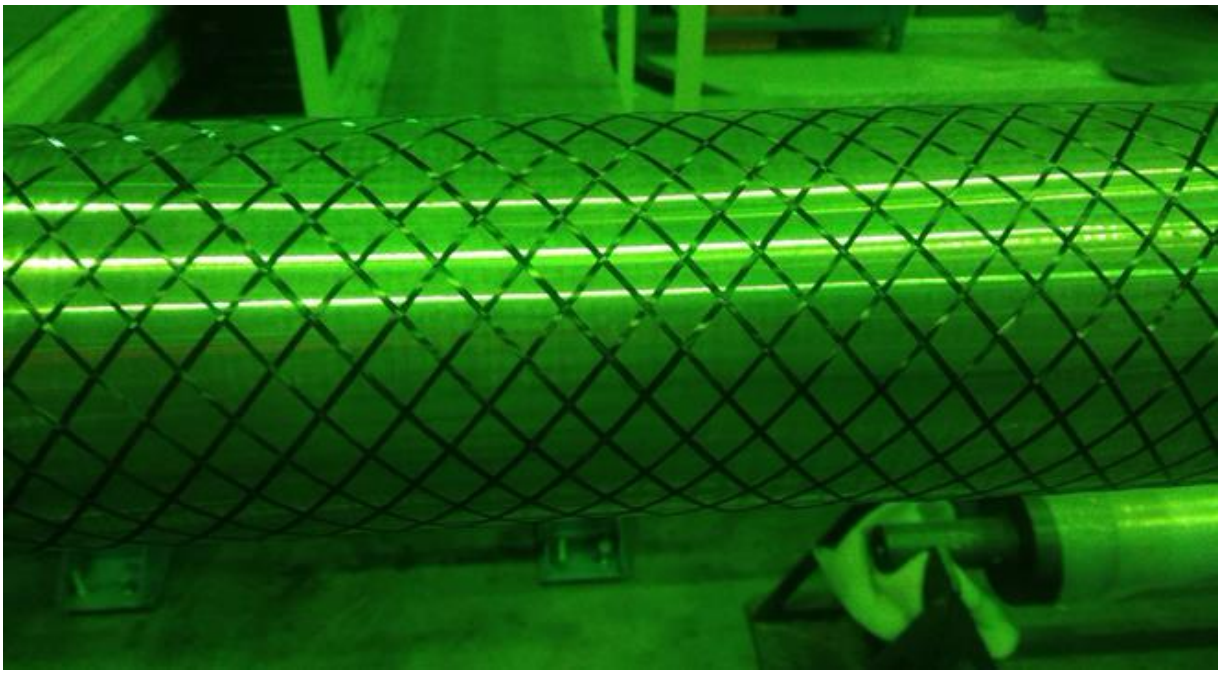
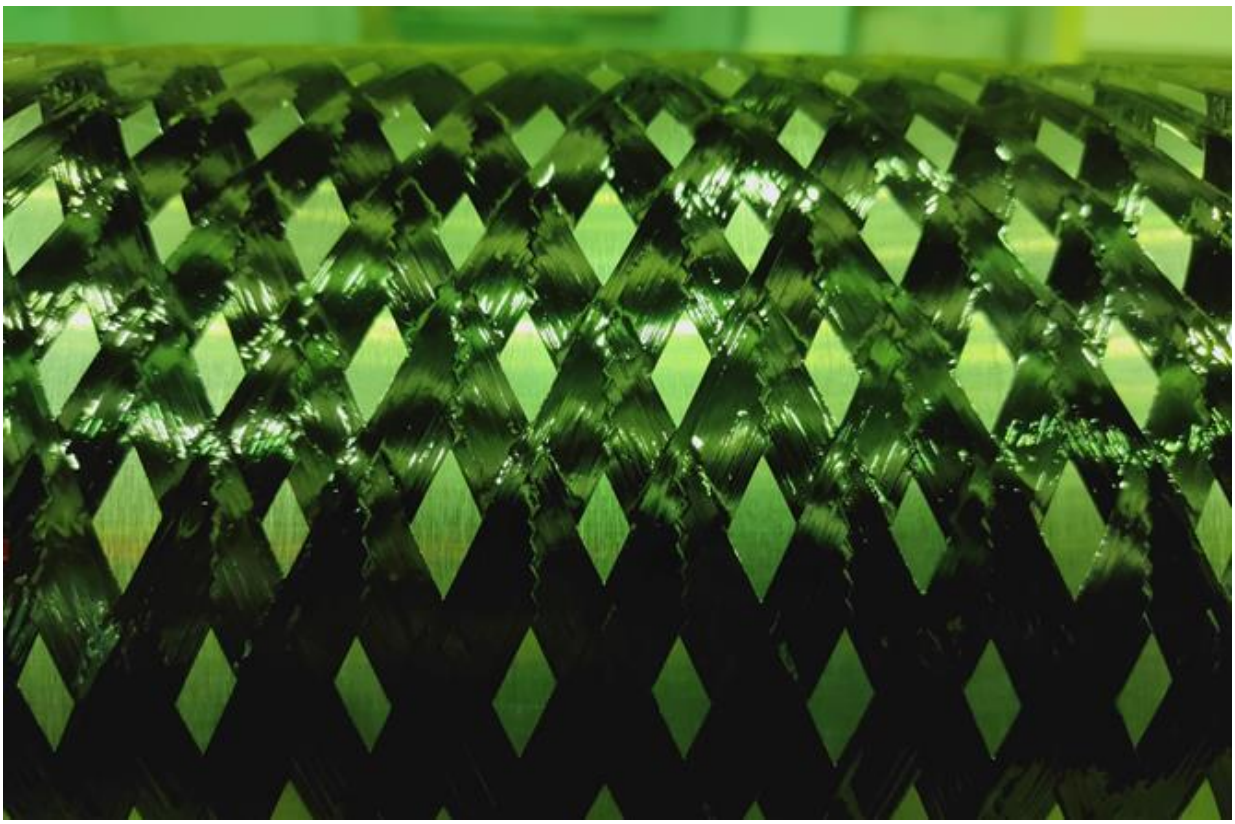


Figure 2. Size control *D*



Picture 3. Size control *E*

Figure 4. Gaps (space) between the bundles

The result of automated image analysis is the possibility of gap sizes density distribution (Figure 5).

Histogram 5 a) shows that the median of the size distribution between white and green dots is about 23 mm (with a minimum size of 19 mm and a maximum of 28).

Histogram 5 b) indicates the presence of an outlier in the vicinity about 4 mm, which corresponds to the gap between two adjacent bundles.

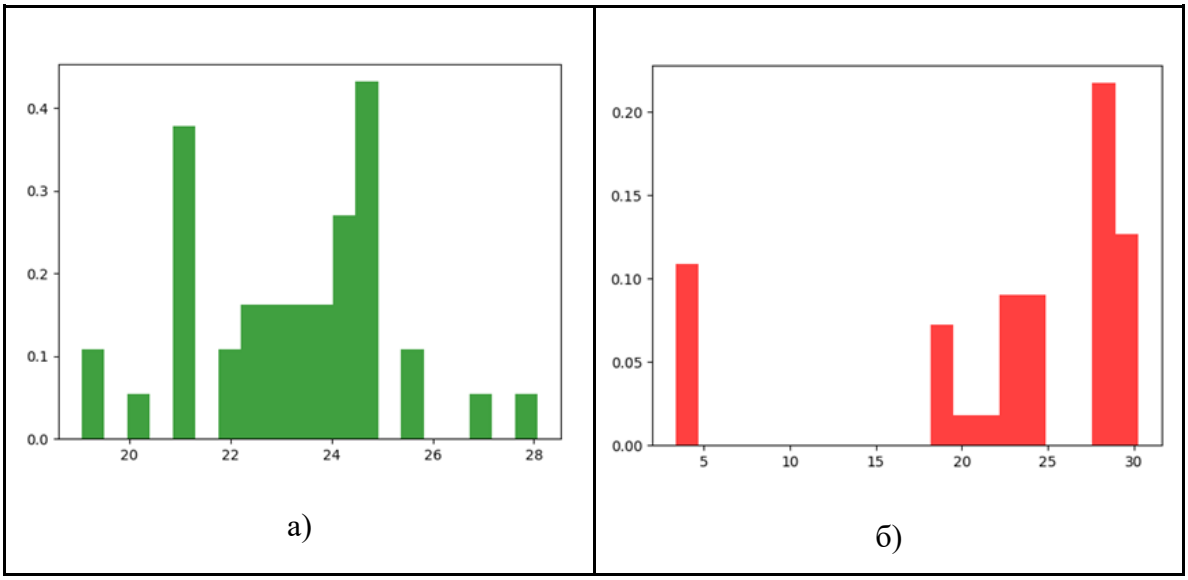


Figure 5. Density of the probability of obtaining the size for the distance: a) between white and green dots of the gap; b) between white and red dots of the gap.

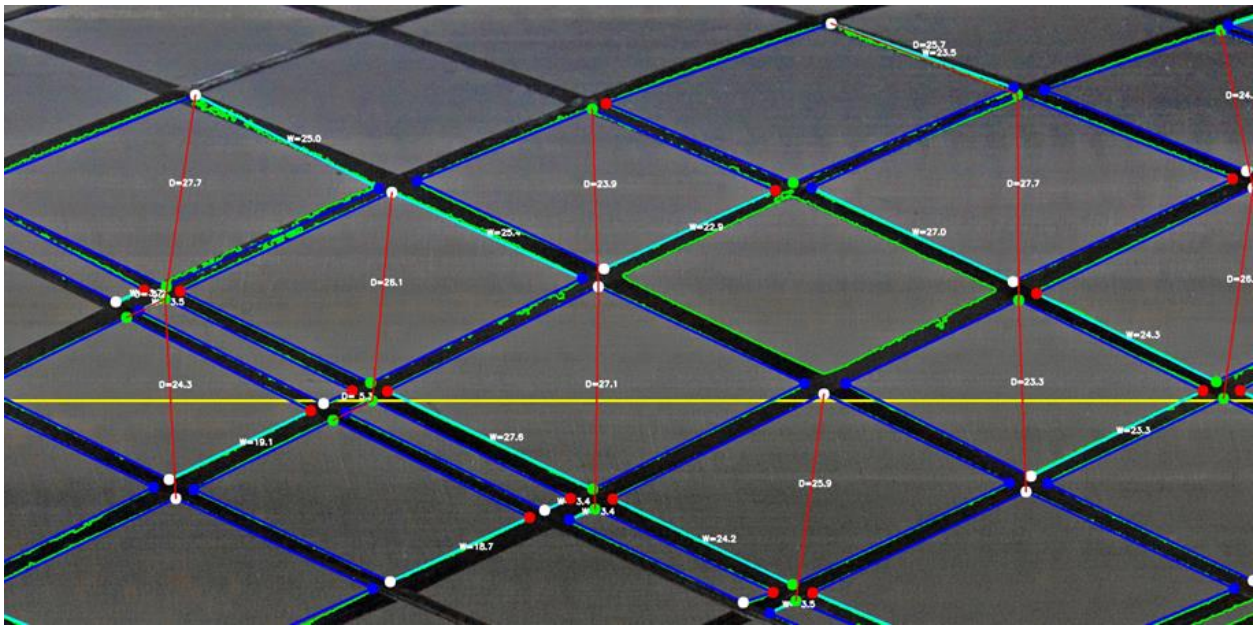


Figure 6. Visualization of the results of automated analysis.

Conclusion

The results obtained are preliminary and can be improved by: optimizing the camera position and lighting; taking into account camera distortion parameters; formation of the development of the surface of sharpening with bundles.

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