Machinery & Energetics. Journal of Rural Production Research. Kyiv. Ukraine. 2018, Vol. 9, No. 4, 149-156
ISSN 2663-1334 (print), ISSN 2663-1342 (online), www.journals.nubip.edu.ua/index.php/Tekhnica

https://doi.org/10.31548/me2018.04.149

UDC 631.1.004

ACCURACY OF CONVERTING VIDEOENDOSCOPY COMBINE HARVESTER USING GENERALIZED MATHEMATICAL MODEL

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Article history: Received: September 2018. Received in the revised form: October 2018. Accepted: November 2018. Bibl. 11, fig. 12, tabl. 2.

Abstract. The article considers analytical models of the formation procedures for the use of video endoscopy in the assessment of indicators of a technical condition of units and mechanisms of combine harvesters. Developed electronic module for video endoscopy in the 2-s readout of the transducer. As a converter to test the correction unit was used that was developed 13-bit fiber-optic converter of the angle. Experimental studies on the installation and podtverdili that before correction instrumental error exceeding 1/4 of a quantum of high order, equal 0,703125°, and accounted for 1,266° of 1.31°. In the result of the algorithm execution code correction was able to reduce the instrumental error to 0,0089 (1.3% from 1/4 of a quantum of high order), which led to regular operation of the scheme of video endoscopy approval of samples and the formation of true sequence. The results of the processing array of the errors obtained before and after correction.

Key words: videoendoscopy, error, parameter, combine harvester.

Introduction

The reliability of the analog-digital conversion [1] is one of the most important indicators of integral accuracy videoendoscopy characterizing the degree of correspondence metrological characteristics of real N-bit converter metrological characteristics of an ideal N-bit quantizer [2].

Objective assessment of the reliability often occurs as in the step of forming predictive validity estimates videoendoscopy newly developed designs and in step metrological certification of real transducers at different stages of the experimental polishing – from prototypes before production parts [3].

From a mathematical point of view, under the conversion reliability is the probability that the total converting the error does not go beyond $\pm 0{,}5\Delta$, or speaking, does not exceed methodical quantization error [4]:

$$P = \int_{-0,5\Delta}^{+0,5\Delta} f(\Delta_\Sigma)\, d\Delta_\Sigma,$$

where Δ_Σ – current quantization step videoendoscopy, $f(\Delta_\Sigma)$ – density distribution total error of the inverter output.

In general $f(\Delta_\Sigma)$ to a song density distribution methodology tilting error Δ_v and the instrumental error Δ_i. It follows that the accuracy of the conversion is substantially defines the value of trust at the probability.

Formulation of problem

For an ideal quantizer density of the instrumental error can be represented as δ-functions [5]:

$$f(\Delta_i) = \begin{cases} 1\ at\ \Delta_i = 0 \\ 0\ at\ \Delta_i \neq 0 \end{cases}$$

so $f(\Delta_\Sigma) = f(\Delta_v)$. From the analog-to-digital conversion is known theory which is subject Δ_v uniform law on the interval $\pm 0{,}5\Delta$. It follows that the validity of any ideal quantizer is equal to 1 [6].

Analysis of recent research results

Therefore, the main task in the process of evaluating the reliability of a theoretical search and validating analytical expressions for $f(\Delta_i)$. In view of the normal, the numerical complexity of tasks usually take the distribution law the characteristics of which are adjusted based on the a priori information contained in the literature reference [7]. However, this approach does not adequately reflect the characteristics of the internal mechanisms of formation and accidental external manifestations of instrumental error, which leads to lack of reliability of the reliability estimates [8].

In this regard, we consider, a new approach to the evaluation of the reliability (method), based on the use of the generalized mathematical model of analog-to-digital conversion, as well as evaluate the reliability of the control error [9].

Predlagaemy method is sequential execution of the following steps [10]:

- forming a transform function ideal videoendoscopy;
- forming a transform function videoendoscopy real;
- finding the difference between these characteristics module;
- forming a numeric array of instrumental errors.

About memo that the implementation of this method of evaluation of reliability can both software and hardware.

In [11] have shown that a generalized mathematical model of the real videoendoscopy can be represented as:

$$N(\alpha) = \sum_{i=1}^{n} F_i\,[V(\alpha, c^0, \Delta c\,)]q_i.$$

Purpose of research

Experimental study was to determine the effect of the proposed correction circuit for conversion accuracy. To test the correction algorithms were used as virtual modeling program modules and designed.

Results of research

Under normal conditions, each quantum instrumental error is considered as a systematic, a plurality of rays across (over the entire range of measurement) as a random variable.

The graph of an ideal quantizer conversion is shown in Figure and the solid line, and the function of converting real videoendoscopy found.

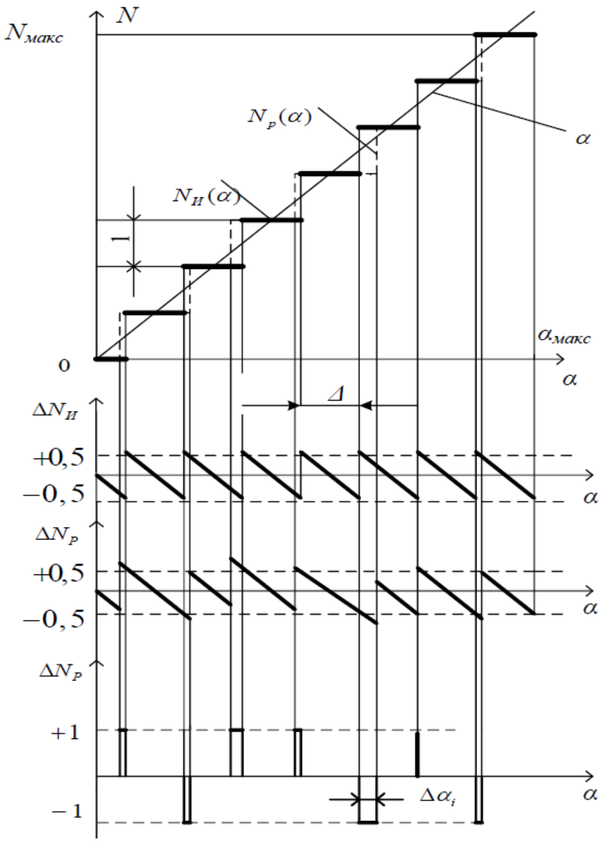


Fig. 1. Errors in the analog-digital conversion.

Expression defines the necessary correlation between the reference information and the verified characteristics converters based on the required reliability of the control error, taking into account the reliability of the inverter output reference code (Fig. 2).

In this paper, virtual modeling software packages and hardware were designed and used for experimental verification and validation, theoretical results.

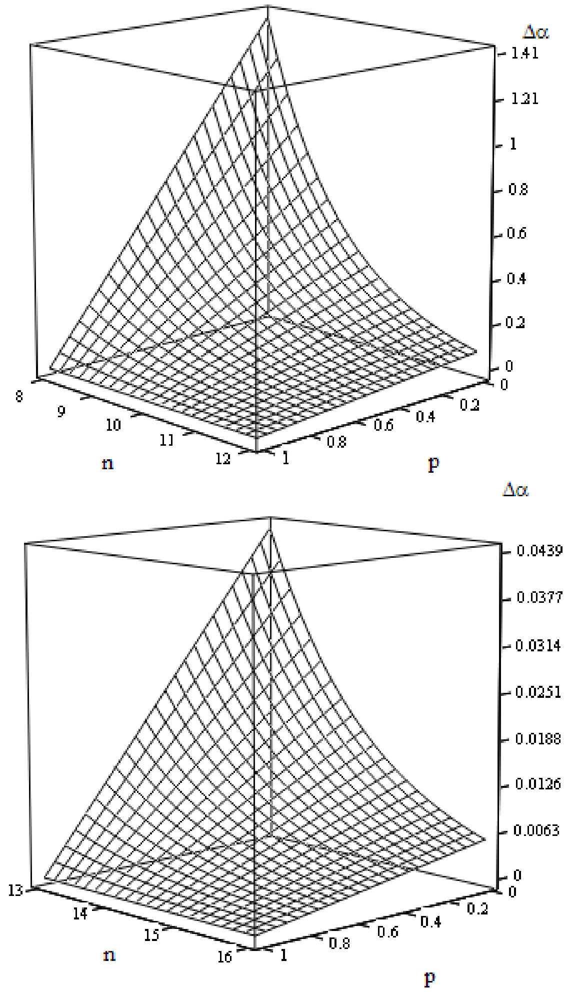


Fig. 2. Graphs allowable instrumental error depending on a predetermined number of bits and reliability conversion.

As a hardware-based was developed in selected ONIL 5 SSAU 8-bit fiber optic digital converter angle PCF-VP-8. To create on the basis of the converter videoendoscopy with structural algorithmic correction developed an original electronic module that allows implement the described in this paper how proactive correction.

Hand (Fig. 3) image videoendoscopy PCF-VP-8 and creates an electronic module.

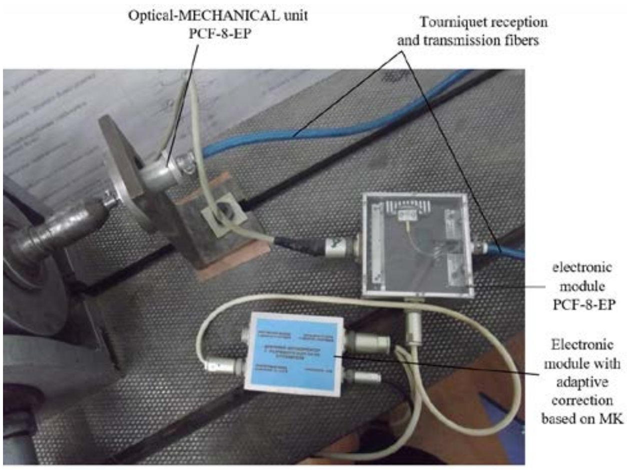


Fig. 3. Converter PCF-VP-8 with the electronic module proactive indications correction.

Comprises eight reception and transmission waveguides (coming and going to an electronic module, respectively), combined in a common harness, whereby the optical radiation is applied to the information reading point code with the code wheel tracks. The ends of the transmitting fibers are arranged on the read line and installed in the handpiece. The ends of the receiving fibers at the tip are installed opposite ends of the corresponding transmission fibers. CD is mounted on the measuring shaft in the bearing. Receiving optical fibers are combined into a bundle, which is part of transceivers harness. The output end of the receiving optical fibers are optically coupled to photodetectors electronic unit. Coded disk drive PCF-EP-8 is formed by photolithography of a thin nickel foil 80 microns thick deposited on its surface layer by electrochemical deposition.

The design of the code disk videoendoscopy PCF-VP-8. nickel 2-5 microns thick. The use of metal code disc instead of glass offers a number of advantages, which include:

- low mass and correspondingly low moment of inertia;
- at resistant to shock loads and vibrations;
- possibility of the CD by soldering, welding, clamping fastening screws, etc.;
- obtaining seating surfaces in a single process with produce code pattern with a high accuracy of dimensions of both the pattern and the seating surfaces (-2 microns);
- atmenshenie losses of optical radiation due to the absence of reflections from the surfaces of transparent and opaque portions of the code pattern on the CD, and also, reducing the gap between the transmitting and receiving ends of the optical fibers (the total clearance can be reduced to 0.5 mm).

Hand suffered coded pattern to form 8-bit inverse Gray code, wherein the logic "0" correspond to the transparent areas, and a logic "1" correspond to the opaque regions of the code tracks. Note that this fabrication technique provides CD that it is closed geometric figure. This eliminates the need for bridges that can reduce the size and the disc drive as a whole.

The height of the code tracks is determined by the capabilities of the optimal placement of the transmitting and receiving ends of the radiating elements and readout system. For this inverter is equal to 1 mm.

Tmayor, the maximum diameter of the CD does not exceed 15 mm at an internal landing hole equal to 7.5 mm withosnost transmitting and receiving ends of the optical fibers is provided by the technological features of the structural elements of fastening ferrules of the fiber optic cable.

The construction of a fiber optic cable.

The fiber optic cable used in the converter PCF-VP-8, 16 comprises monofilament fibers, of which 8 are used for transmission, and the other – for receiving the modulated radiation (Fig. 4).

When manufacture of the multichannel optical fiber communication lines, designed to read information from the multi-bit code masks VOTSPU transmitting portion is made as a fiber-optic optical collector, optically connected to the radiator. In this case the input ends of optical fibers arranged generally capillary installed in a ferrule.

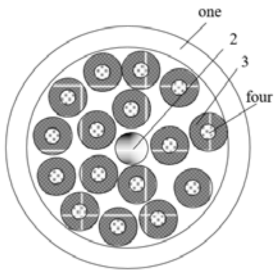


Fig. 4. The structure of the fiber-optic cable videoendoscopy PCF-VP-8: 1 - cable sheath of organic silicon-rubber; 2 - central reinforcing core; 3 - fibers; 4 - core optical fibers.

Input optical radiation from the radiation source (see. Fig. 5) is carried out directly in the core package of 8 optical fibers, crimped metal sleeves and summed through the capillary to the LED. This embodiment provides a simple construction with an acceptable level of power loss.

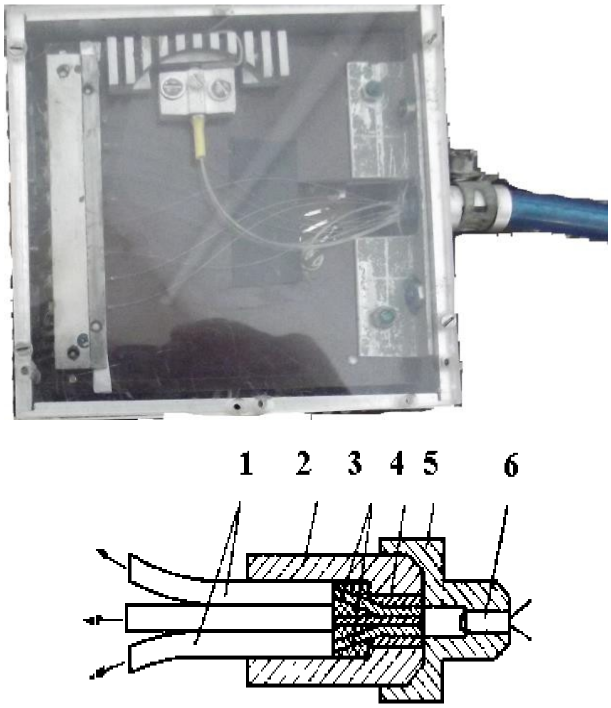


Fig. 5. Input optical radiation in videoendoscopy PCF-VP-8: 1 - transmitting a bundle of optical fibers; 2, 5 - crimped metallic sleeve; 3 - core optical fiber; 4 - capillary; 6 - emitting LED.

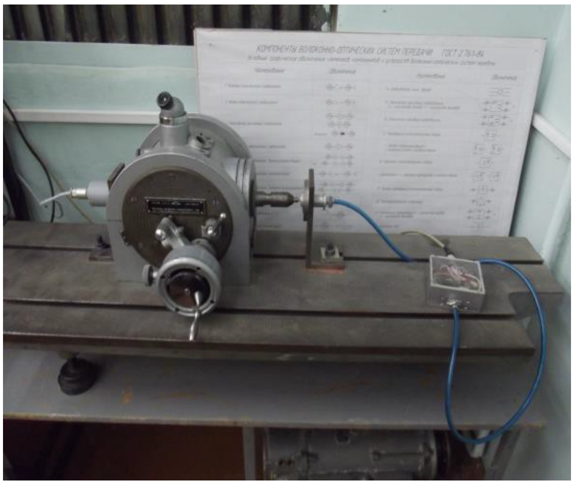
Pass the 8 optical fibers on one end side of the electronic module embedded in the manifold with a bore diameter, with a diameter conjugate used emitter. At the other end (from the opto-mechanical unit) are terminated with a landing tips adjust diameters 2.5 - 0.002 mm.

The output ends of the receiving fibers terminated with an electronic module neyustirovannymi tipped with bore diameter of 2.8 mm for mating with an electronic module photodetectors.

Uses monofilament type CCF 150/100 125/50 or CCF. The fiber-optic cable. Cable length defined by the distance spacing the controlled object, and an electronic data processing unit. The whole bundle of fibers encased in a protective shell of organic silicon rubber. The external diameter is 11 mm.

Cspruce experimental study was to determine the effect of the proposed correction circuit for conversion accuracy. To test the correction algorithms were used as virtual modeling program modules (PM), and designed to KEM PUF- VP-8.

To check the functioning of the developed algorithms surveyed "classical" EM PCF-VP-8 and KEM. Error numerical array obtained via automated installation executed on the basis of optical EDC-dividing head 60. In an exemplary photoelectric transducer used 14-bit converter angle PPFE-14 "Mekhitar" (Fig. 6).



a

b

Fig. 6. Calibration unit (a), the photoelectric converter 14-bit angle PPFE-14 "Mkhitar" (b)

The results of measurements of optical power at the outputs of waveguides PUF-VP-8 without correction are presented in Table 1. Measurement of optical signals carried through a digital optical power meter OM3-65.

Table 1. Results of measurement of optical power in the PCF-EP-8 without correction.

Channel	Power radiation in the entered channel $P_{aboutFri}$, nW
1	47
2	58
3	93
4	42
5	85
6	107
7	67
8	49

The above data were used for numerical simulation of corrective actions.

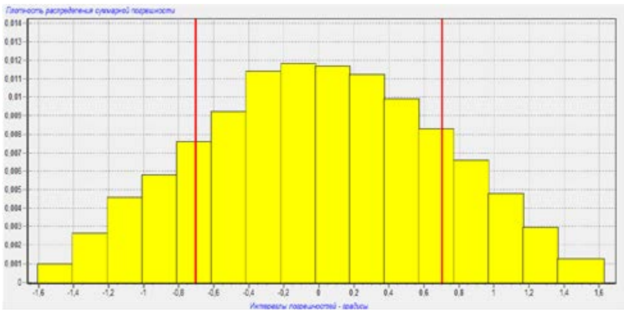
Table 2 shows the results of a numerical experiment of error correction, caused by the uneven division of the optical power of the radiator in Y-coupler.

Table 2. Results adjusted optical power based on numerical experiment.

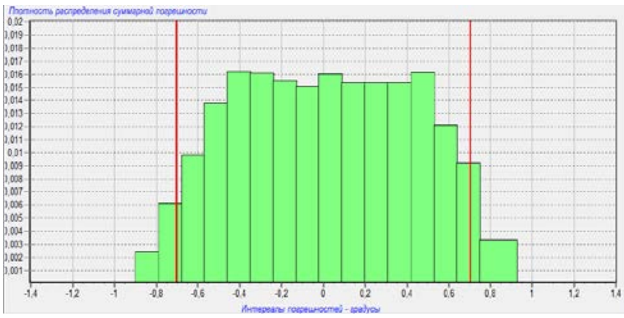
Channel	Power radiation in the entered channel $P_{aboutFri}$, nW
1	99
2	102
3	102
4	101
5	102
6	102
7	101
8	100

Table 2 is seen that after this kind of autocorrection dispersion of the optical powers at the outputs fibers significantly decreased (from 60 nW to 3).

Hand Fig. 7 shows a histogram of the distribution of the error total error before and after correction.



a



b

Fig. 7. The histogram distribution error PCF-VP-8: a) of correction; b) after correction of the radiation capacity.

As follows from Fig. 7 and to correct the shape of the histogram is close to a normal distribution. The reliability of the output code in this case is 0.67, the maximum absolute error 1.62 after applying correction the accuracy of the output code videoendoscopy increased to 0.92.

Thus, when using this method, the correction accuracy of the output code videoendoscopy increased 1.37 times, the error has decreased by 1.76.

Note that to achieve full compensation instrumental error correction method of the uneven division transmitter optical power in the Y-coupler is generally not possible. This is due to the fact that in addition to the unevenness factor of the input radiation into fiber optic link, to affect the conversion result a number of other instrumental errors that are not corrected with this method.

To implement this type of correction algorithms are used, as shown in Fig. 8 (numerical experiment) and one (natural experiment).

Verification data before and after the correction was performed using a test version «OptoElectronic Workspace» (Figure 8). Retrieves data from the installation converters with EDC-60 provides tools «CONER», created by the author in the year 2017 and renovated in 2018 to test the results of this thesis (Fig. 8).

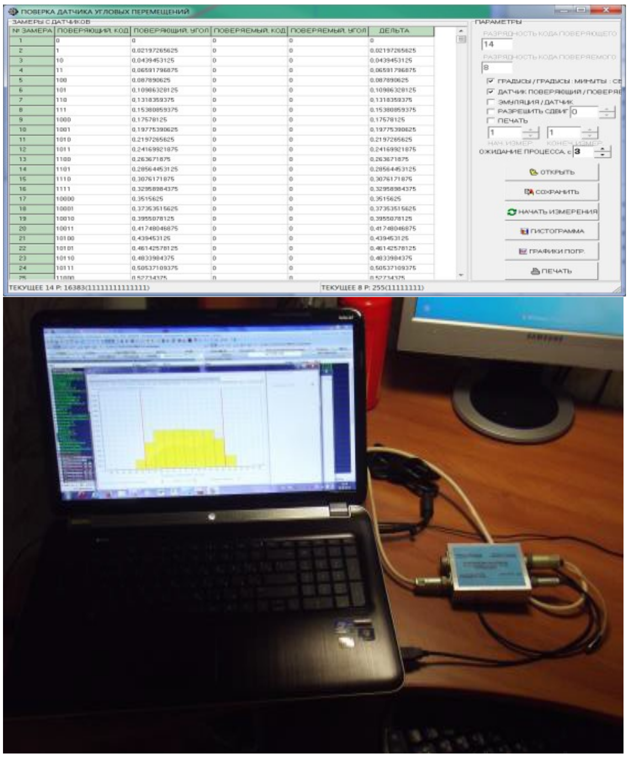


Fig. 8. PIC processing primary data calibration unit: a) coner, b) OptoElectronic Workspace.

Histograms after applying the correction method in the virtual mdressed shown in Fig. 9 and Fig. 10 PCF-VP-8 KEM. From the Fig. 9 is follows that the accuracy of the output code videoendoscopy after applying this type of compensation has increased from 0.67 to 1.

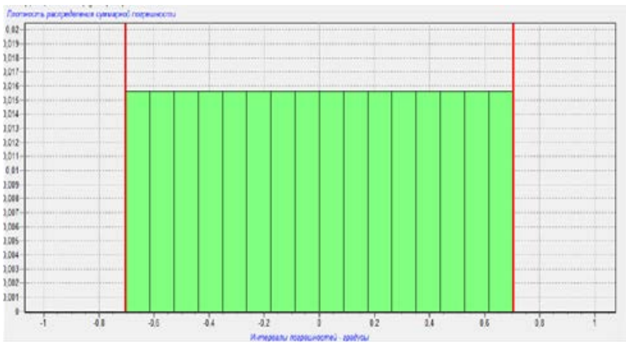


Fig. 9. The histogram distribution error PCF-VP-8 in the virtual simulation after correction algorithm thresholds of comparators.

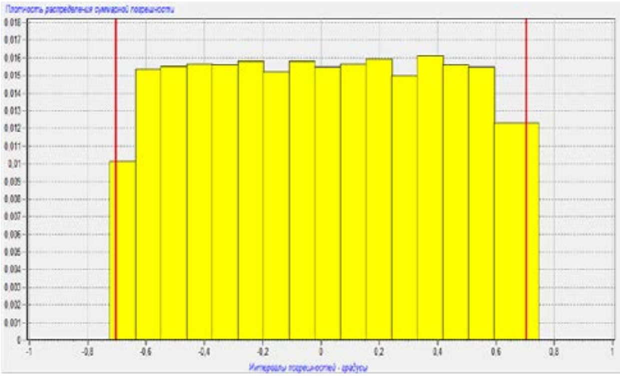


Fig. 10. The histogram distribution error PCF-VP-8, with full-scale experiment after correction "modified" algorithm thresholds.

In this case, it should be noted that the difference between the virtual and field experiments due to some simplifications virtual model, in particular, not all simulated factors that introduce errors in the operation of EM (e.g., ADC and DAC relied ideal quantizers corresponding to the bit). However, it should be noted that the difference between the minimum and reliability in the full-scale software and virtual experiments was not more than 0.8%.

Designed electronic module for PCF-EP-8 can be used in the composition 2. As the base 2 videoendoscopy for testing correcting unit used in the developed-5 ONIL SSAU 13- bit fiber optic transducer angle PCF-VP-13, a block diagram is shown in Fig. 10.

In this videoendoscopy exit ends of optical fibers transmitting (SS) are disposed in the openings counting disk (CD) opposite the respective information reading points with a code disk (CD) (Fig. 10).

Unlike the PCF converter VI-8-coded disc videoendoscopy PCF-Bn 13 comprises 6 tracks coarse frame constructed in accordance with the mask and the inverse Gray code, accurate reading one track disposed on the periphery of the code disc (Fig. 10).

To make the construction the necessary rigidity and flatness of the plane of the code disk is connected with a code carrier substrate (NPC).

HKP represents a monolithic construction consisting of two concentric annular webs, between which the code field, which is a concentric code track formed in accordance with the mask CD. All opaque portions of code tracks NKP connected directly or through each other and with the inner outer annular webs forming the closed geometric figure that provides at an appropriate thickness HKP its necessary mechanical rigidity and strength. Thus the deviation from flatness at the appropriate NCP its thickness is comparable with glass KD.

Figure HKP pattern repeats CD with the only difference that the angular dimensions HKP webs made with guaranteed negative tolerance relative to sizes corresponding elements KD. Figure executed in NLO electroerosion method with the working instrument thickness 0.5-0.8 mm, which provides a guaranteed negative tolerance webs NKP when driving tool according to a nominal dimension of the boundary boxes. Precision CD etching with high accuracy to form a boundary shift of the output code defined within the boundaries of the code disk elements. HKP and KD are rigidly interconnected along a plane so that the midpoints of their respective code elements coincide. The height of the code tracks is determined by the capabilities of the optimal placement of the transmitting and receiving ends of the radiating elements and readout system.

Tmayor, the maximum diameter of the CD does not exceed 50 mm at an internal landing opening equal to 6 mm.

Alignment of transmitting and receiving ends of the optical fibers is provided by the technological features of the structural elements of fastening ferrules of the fiber optic cable.

Reading disk (CD) is made of similar technology. It comprises apertures located opposite the information reading point to the CD and provides an optical connection between the transmitting and receiving optical fibers. SD still fortified on transmitter housing part.

Harness receiving fibers CP transmits modulated optical signals to the reference coarse fotousiliteley located on board PUF- VP-13 carrying out the conversion of the photocurrent into proportional voltage signals to them. These signals are applied to the inputs integrated in CEM 8-channel 10-bit ADC (signals d0...d5).

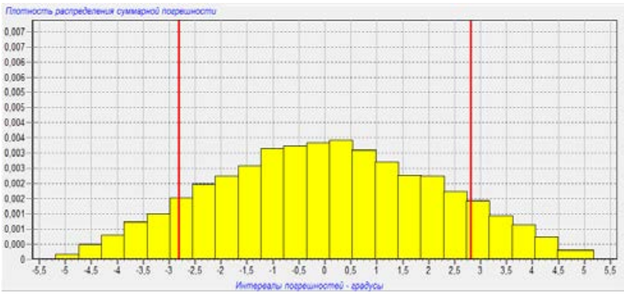


Fig. 11. Histogram distribution error GO PCF-VP-13 under full-scale experiment before correction code GO.

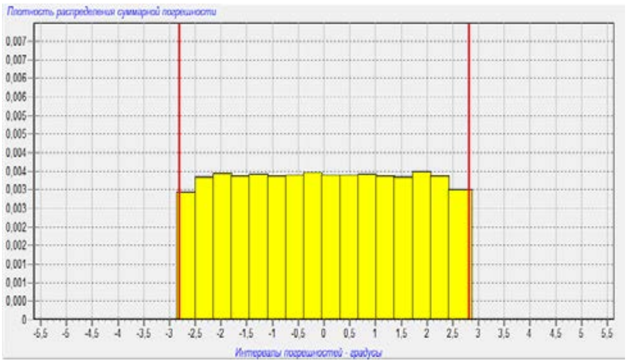


Fig. 12. The histogram distribution error GO PCF-VP-13, with full-scale experiment after correction "modified" algorithm thresholds.

The maximum number of bits accurately determined reference positional accuracy and stability of the main and auxiliary signals, the nonlinearity of the information signal and bit ADC.

The sample Followed PCF-VP-13 defective coded disc was used, which is known to manufacture errors exceed allowable mismatch error of samples equal to 1/4 period MSB accurate reading. This circumstance has led to inconsistent dispensing codes coarse and fine readings, and hence inoperable converter as a whole. The main purpose of the experiment was to ensure regular functioning of the inverter due to a manufacturing error correction code disk channel coarse reference.

As can be seen, investigated the PCF-VP-13 comprises opto-mechanical module (OMM), optical cable and an electronic module board. receiving the optical fibers of cable exits are separated by respective photodetectors, disposed within openings multichannel optical coupler. Inputs 8 channel ADC unit correcting conductors are connected through the input terminal X1. To the outputs of coarse fotousiliteley channels (CS) and precise (TO) samples. accurate reference signals are digitized in the ADC and is converted into a precise reference code in accordance. Output signals fotousiliteley GO after implementing the correction algorithm are converted into code CS.

The schema matching samples and the formation of the true sequence the output code values, which was not observed before connecting CEM. Results array processing errors obtained before and after correction are shown in Fig. 11 and Fig. 12. If the accuracy of the Civil Code to the use of correction was 0.793 after correction it was 0.984.

Conclusions

1. The analysis metrological characteristics videoendoscopy expressions are obtained depending on the required error videoendoscopy validity bit depth conversion and back, as well as the expression for the error reliability.

2. Virtual experiments and field tests have shown:

- developed algorithms and MC of the program can reduce the effect of the total instrumental error of 2.17 times (1.626 to 0.747);

- code to increase reliability of the output videoendoscopy PCF-EP-8 with the created electronic module MC on the basis of a result of AT91SAM7S256 autocorrection and circuit techniques is possible in times of 1.47-0.67 to 0.983;

2. Provided and tested the ability to work to create an electronic module comprising a videoendoscopy while retaining all the benefits of auto-correction.

3. By virtual simulation tools videoendoscopy and software-tool kit will significantly reduce complexity and shorten development time and auto-correction algorithms and methods.

References

1. *Boyko, A. I., Novitskiy, A. V.* (2018). Mathematical model of reliability of human-machine system under reduced efficiency of its work is generalized. Machinery & Energetics. Journal of Production Research. Kyiv. Ukraine. Vol. 9, No 3. 97-101. DOI: 10.31548/machenergy.2018.03.097-101.

2. *Aliev, E. B., Bandura, V. M., Pryshliak, V. M., Yaropud, V. M., Trukhanska, O. O.* (2018). Modeling of mechanical and technological processes of the agricultural industry. INMATEH. Agricultural Engineering. Bucharest. Vol. 54. No 1. 95-104. Scopus. WoS.

3. *Aulin, V. V., Grinkov, A. V., Lysenko, S. V.* (2015). Theoretic-physical approach to diagnostic information

about the technical condition of units of mobile agricultural machinery. Bulletin of Kharkov national technical University of agriculture named Peter Vasilenko. Kharkov. Vol. 158. 252-262.

4. *Delphi* Diesel Systems. (2018). Publication №: DDNX125(EN) Delphi Diesel Aftermarket Operations UK 2. 76.

5. *Hampel, R., Kurr, D., Scbefenadcer, H.* (2015). Elektronisches Messistem zur digitalen Erfassung und Auswertung von Indikatordiagrammen. MTZ. 36. № 2. 33-38.

6. *Gress, K. and Kushwaha, R.* (2016). Perspective on Service and Parts for Combine Harvesters. SAE Technical Paper 961782. https://doi.org/10.4271/961782.

7. *Kalinichenko, D. Yu., Rogovskii, I. L.* (2017). Mathematical apparatus of the description of the route maintenance of combine harvesters in accordance with the detection of combinations of failures.Scientific Herald of National University of Life and Environmental Science of Ukraine. Series: Technique and energy of APK. Kiev. Vol. 275. 337-346.

8. *Rogovskii, I. L.* (2017). Conceptual framework of management system of failures of agricultural machinery. Scientific Herald of National University of Life and Environmental Science of Ukraine. Series: Technique and energy of APK. Kiev. Vol. 262. 403-411.

9. *Kalinichenko Dmytro, Rogovskii Ivan*. (2018). Method for Determining Time of next Maintenance of Combine Harvesters. TEKA. An International Quarterly Journal on Motorization, Vehicle Operation, Energy Efficiency and Mechanical Engineering. Lublin–Rzeszów. Vol. 18. No 1. 105-115.

10. *Kalinichenko, D. Yu., Rogovskii, I. L.* (2018). General provisions structural diagram of awp operator-diagnostician combine harvester. Machinery & Energetics. Journal of Rural Production Research. Kyiv. Vol. 9. No 2. 155-160.

11. *Kalinichenko, D. Yu., Rogovskii, I. L.* (2018). Solution to problem of recognition of combinations of defect aggregates combine harvester on basis of INS. Machinery & Energetics. Journal of Rural Production Research. Kyiv. Vol. 9, No 3. 159-168. DOI: 10.31548/machenergy.2018.03.159-168.

Список літератури

1. *Бойко А. І., Новицький А. В.* Узагальнена математична модель надійності системи «людина-машина» при зниженні ефективності її роботи. Machinery & Energetics. Journal of Production Research. Kyiv. Ukraine. 2018. Vol. 9, № 3, P. 97–101. DOI: 10.31548/machenergy.2018.03.097-101.

2. *Aliev E. B., Bandura V. M., Pryshliak V. M., Yaropud V. M., Trukhanska O. O.* Modeling of mechanical and technological processes of the agricultural industry. INMATEH. Agricultural Engineering. Bucharest. 2018. Vol. 54. No 1. 95-104. Scopus. WoS.

3. *Аулін В. В., Гриньків А. В., Лисенко С. В.* Теоретико-фізичний підхід до діагностичної інформації про технічний стан агрегатів мобільної сільськогосподарської техніки. Вісник Харківського національного технічного університету сільського господарства імені Петра Василенка. Харків. 2015. Вип. 158. С. 252–262.

4. *Delphi* Diesel Systems. Publication №: DDNX125(EN) Delphi Diesel Aftermarket Operations UK 2. 2018. 76 p.

5. *Hampel R., Kurr D., Scbefenadcer H.* Elektronisches Messistem zur digitalen Erfassung und Auswertung von Indikatordiagrammen. MTZ. 2015. 36. № 2. P. 33–38.

6. *Gress K., Kushwaha R.* Perspective on Service and Parts for Combine Harvesters. SAE Technical Paper 961782. 2016. https://doi.org/10.4271/961782.

7. *Kalinichenko D. Yu., Rogovskii I. L.* Mathematical apparatus of the description of the route maintenance of combine harvesters in accordance with the detection of combinations of failures.Scientific Herald of National University of Life and Environmental Science of Ukraine. Series: Technique and energy of APK. Kiev. 2017. Vol. 275. 337-346.

8. *Rogovskii I. L.* Conceptual framework of management system of failures of agricultural machinery. Scientific Herald of National University of Life and Environmental Science of Ukraine. Series: Technique and energy of APK. Kiev. 2017. Vol. 262. 403-411.

9. *Kalinichenko Dmytro, Rogovskii Ivan*. Method for Determining Time of next Maintenance of Combine Harvesters. TEKA. An International Quarterly Journal on Motorization, Vehicle Operation, Energy Efficiency and Mechanical Engineering. Lublin–Rzeszów. 2018. Vol. 18. No 1. 105-115.

10. *Kalinichenko D. Yu., Rogovskii I. L.* General provisions structural diagram of awp operator-diagnostician combine harvester. Machinery & Energetics. Journal of Rural Production Research. Kyiv. 2018. Vol. 9. No 2. 155-160. DOI: 10.31548/machenergy.2018.02.155-160.

11. *Каліченко Д. Ю., Роговський І. Л.* Рішення завдання розпізнавання сполучень дефектів агрегатів зернозбирального комбайна на основі ШНМ. Machinery & Energetics. Journal of Rural Production Research. Kyiv. Ukraine. 2018, Vol. 9. № 3. P. 159–168. DOI: 10.31548/machenergy.2018.03.159-168.

ДОСТОВІРНІСТЬ ПЕРЕТВОРЕННЯ ВІДЕОЕНДОСКОПІЇ ЗЕРНОЗБИРАЛЬНИХ КОМБАЙНІВ З ВИКОРИСТАННЯМ УЗАГАЛЬНЕНОЇ МАТЕМАТИЧНОЇ МОДЕЛІ

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Анотація. У статті розглянуті аналітичні моделі формування процедури використання технології відеоендоскопії при оцінці показників технічного стану вузлів і механізмів зернозбиральних комбайнів. Розроблений електронний модуль для відеоендоскопії у складі 2-х відлікового перетворювача. У якості перетворювача для тестування коригуючого блоку використовувався розроблений 13-розрядний волоконно-оптичний перетворювач кута. Проведені експериментальні дослідження на установці, і підтвердили, що до корекції інструментальна похибка перевищувала 1/4 кванта старшого розряду, що дорівнює 0,703125°, і становила 1,266...1,31°. В результаті виконання алгоритму корекції коду вдалося знизити інструментальну похибку до 0,0089 (становить 1,3 відсотка від 1/4 кванта старшого розряду), що призвело до штатного функціонування схеми відеоендоскопії узгодження відліків і формування істинної послідовності. Наведено результати обробки масивів похибок, отриманих до та після корекції.

Ключові слова: відеоендоскопія, похибка, параметр, зернозбиральний комбайн.

ДОСТОВЕРНОСТЬ ПРЕОБРАЗОВАНИЯ ВИДЕОЭНДОСКОПИИ ЗЕРНОУБОРОЧНЫХ КОМБАЙНОВ С ИСПОЛЬЗОВАНИЕМ ОБОБЩЕННОЙ МАТЕМАТИЧЕСКОЙ МОДЕЛИ

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Аннотация. В статье рассмотрены аналитические модели формирования процедуры использования технологии видео эндоскопии при оценки показателей технического состояния узлов и механизмов зерноуборочных комбайнов. Разработан электронный модуль для видеоэндоскопии в составе 2-х отсчётного преобразователя. В качестве преобразователя для тестирования корректирующего блока использовался разработанный 13-разрядный волоконно-оптический преобразователь угла. Проведены экспериментальные исследования на установке, и подтердили, что до коррекции инструментальная погрешность превышала 1/4 кванта старшего разряда, равную 0,703125°, и составляла 1,266…1,31°. В результате выполнения алгоритма коррекции кода удалось снизить инструментальную погрешность до 0,0089 (составляет 1,3 процента от 1/4 кванта старшего разряда), что привело к штатному функционированию схемы видеоэндоскопии согласования отсчетов и формированию истинной последовательности. Приведены результаты обработки массивов погрешностей, полученных до и после коррекции.

Ключевые слова: видеоэндоскопия, погрешность, параметр, зерноуборочный комбайн.