ELECTRONICS AND ELECTRICAL ENGINEERING

ISSN 1392 – 1215 2010. No. 7(103)

ELEKTRONIKA IR ELEKTROTECHNIKA

T 170 ELECTRONICS

ELEKTRONIKA

Two-Parameter Electronic Devices Quality Models

D. Eidukas, R. Kalnius

Cathedral of Electronics Engineering, Kaunas University of Technology,
Studentų str. 50, LT-51368 Kaunas, Lithuania, phone: +370 37 351389, e-mail: danielius.eidukas@ktu.lt

Introduction

Multiparameter mechatronics product defect level nonlinear transformation models in continuous quality control, evaluating separate parameter and the whole product probability characteristics also first and second type errors, when products are classified, described in [1-4]. Electronic device [ED] quality level probabilistic models, expressed through separate parameters probabilistic characteristics, when defect levels by separate parameters are characterized using beta densities described in [5–8]. ED quality level directly transformed probabilistic characteristics models, dependent from different parameter probabilistic characteristics transformations and controlled parameters nomenclature variation, when all condemned ED are repaired immediately after control operation and returned for repeated control with localized repair operation, for fixed second type classification errors by different parameters, has been designed. Linear transformed defect level models, for different parameters [9–12] are found and used for control system functioning modeling.

Initial models

For further analysis, we use defected ED probabilities by *i*-th parameter θ_i and also good ED probabilities $\eta_i=1-\theta_i$ characteristic models [11-13] used once more, when $\theta_i \sim \mathrm{Be}(b_i, a_i)$, $\eta_i \sim \mathrm{Be}(b_i, a_i)$ – beta laws with parameters a_i, b_i,

where $\mathrm{E}\theta_i = \mu_i = \dfrac{a_i}{a_i+b_i}$, $\mathrm{E}\eta_i = 1-\mu_i = \overline{\mu}_i$ – averages,

$$\mathrm{V}\theta_i = \sigma_i^2 = \frac{\mu_i \overline{\mu}_i}{a_i+b_i+1} = \mathrm{V}\eta_i \text{ – dispersion s,}$$

$$g_i(\theta_i) = B^{-1}(a_i, b_i)\theta_i^{a_i-1}(1-\theta_i)^{b_i-1},$$
$$\varphi_i(\eta_i) = g_i(1-\eta_i) \text{ – densities,}$$

when

$$B(a_i, b_i) = \frac{\Gamma(a_i)\Gamma(b_i)}{\Gamma(a_i+b_i)} \text{ – beta functions,}$$
$$\Gamma(z) \text{ – gama function.}$$

For all ℓ – parametric ED $\eta = \prod_{i=1}^{\ell} \eta_i$, $\theta = 1-\eta$, $E_n =$

$= \overline{\mu} = \prod_{i=1}^{\ell} \overline{\mu}_i$, $\mathrm{E}\theta = \mu = 1-\overline{\mu}$.

Dispersion by two parameters (i=1, 2) $\mathrm{V}\theta_{12} = \sigma_{12}^2 = \sigma_1^2\overline{\mu}_2^2 + \sigma_2^2\overline{\mu}_1^2 + \sigma_1^2\sigma_2^2$.

Then link σ_{12}^2 with σ_{34}^2 or σ_{12}^2 with σ_3^2 etc, until θ^2 by all ℓ parameters.

Distribution functions $\Phi(\eta)$, $\mathrm{G}(\theta)$ and densities $\varphi(\eta)$, $g(\theta)$ for all electronic device – by [13–15].

Common linear transformation models

Analyzing defect level θ_i linear transformation to defect level τ_i (Fig. 1). Single-stage control K with localized repair operation R is characterized by second type error probability β_{Ri} – in operation R.

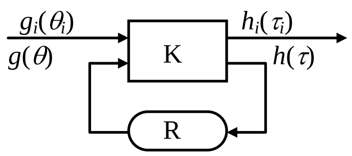

Fig. 1. Single-stage continuous control schematics

If β_{Ri}=const. exists and ED repeats ("spins") through these operations, until all are recognized as good (first type errors probability α_i=0), then both operations K and R are characterized in generalized probability β_{0i} [7]

$$\beta_{0i} = \frac{\beta_i}{1-\beta_{R_i}(1-\beta_i)}, \quad i = 1-\ell. \qquad (1)$$

If control system is made of k serial stages, then for all system by i-th parameter we get (when every stage is characterized $\beta_{0i}(j)$)

$$\beta_{0i} = \prod_{j=1}^{k} \beta_{0i}(j), \quad j = 1 - k\,. \qquad (2)$$

After control K defected ED probability τ_i and good ED probability $\zeta_i = 1 - \tau_i$ by i-th parameter are equal [2]

$$\tau_i \beta_{0i} \theta_i\,,\ \zeta_i = \overline{\beta}_i + \beta_{0i}\eta_i\,,\ \overline{\beta}_i = 1 - \beta_{0i}\,. \qquad (3)$$

Averages and dispersions are:

$$\begin{cases} \mathrm{E}\,\tau_i = \mu_{\tau_i} = \beta_{0i}\mu_i\,,\ \mathrm{E}\,\zeta_i = \overline{\mu}_{\tau_i} = 1 - \mu_{\tau_i}\,, \\ \mathrm{V}\,\tau_i = \mathrm{V}\,\zeta_i = \sigma^2_{\tau_i} = \beta^2_{\tau_i}\sigma_i^2\,. \end{cases} \qquad (4)$$

Beta densities $g_i(\theta_i), \varphi_i(\eta_i)$ after control by [13–15] transforming to generalized beta densities $h_i(\tau_i)$ and $\dot{\varphi}_i(\zeta_i)$ with τ_i, ζ_i variation interval $\tau_i \in (0,\ \beta_{0i})$ and $\zeta_i \in (\overline{\beta}_i\,, 1)$:

$$\begin{cases} h_i(\tau_i) = \dfrac{B^{-1}(a_i, b_i)}{\beta_{0i}^{a_i + b_i - 1}} \tau_i^{a_i - 1} (\beta_{0i} - \tau_i)^{b_i - 1},\ \tau_i \in (0, \beta_{0i}), \\ \dot{\varphi}_i(\zeta_i) = \dfrac{B^{-1}(a_i, b_i)}{\beta_{0i}^{a_i + b_i - 1}} (1 - \zeta_i)^{a_i - 1} (\zeta_i - \overline{\beta}_i)^{b_i - 1} \zeta_i \in (\overline{\beta}_i, 1). \end{cases} \qquad (5)$$

For all ED probabilities τ and ζ general digital characteristics after control process are

$$\mathrm{E}\zeta = \prod_{i=1}^{\ell} \overline{\mu}_{\tau_i} = \overline{\mu}_{\tau}\,, \mathrm{E}\,\tau = \mu_\tau = 1 - \overline{\mu}_\tau. \qquad (6)$$

By two parameters (i=1,2)

$$\mathrm{V}\,\tau_{12} = \mathrm{V}\,\zeta_{12} = \sigma^2_{\tau_{12}} = \sigma^2_{\tau_1}\overline{\mu}^2_{\tau_2} + \sigma^2_{\tau_2}\overline{\mu}^2_{\tau_1} + \sigma^2_{\tau_1}\sigma^2_{\tau_2}\,. \ (7)$$

Later σ^2_τ is found analogically (connecting) like σ^2.

If j-th parameter during control process, $j \in (1 - \ell)$, is not checked, then $\beta_{0j} = 1$ and $\tau_j \equiv \theta_j$, $h_j(\tau_j) \equiv g_j(\theta_j)$. Stochastic value τ, ζ distribution functions $H(\tau)$, $\dot{\Phi}(\zeta)$ and densities $h(\tau)$, $\dot{\varphi}(\zeta)$ are analyzed farther.

Electronic device, when ℓ=2. Stochastic values ζ and τ with error probabilities β_{01}, β_{02} varies in interval

$$\zeta \in (\overline{\beta}_0, 1),\ \tau \in (0, \beta_0); \qquad (8)$$

here $\overline{\beta}_0 = \overline{\beta}_1\overline{\beta}_2\,, \beta_0 = 1 - \overline{\beta}_0\,,\ \overline{\beta}_i = 1 - \beta_{0i}\,,\ i = 1, 2\,.$

Value $\zeta = \zeta_1\zeta_2$ possible values range $\zeta \in (\overline{\beta}_1\overline{\beta}_2, 1)$ in coordinate system (ζ_1, ζ_2) is a rectangular, restricted with lines $\zeta_1 = \zeta_2 = 1, \zeta_1 = \overline{\beta}_1\,, \zeta_2 = \overline{\beta}_2$ (Fig. 2). On the tops of the rectangular ζ gets values $\overline{\beta}_1\overline{\beta}_2$, $\overline{\beta}_1\,, \overline{\beta}_2$ and 1. When $\overline{\beta}_1 \neq \overline{\beta}_2$, indicated ζ values on rectangular tops divide the whole ζ variation interval to 3 partial intervals dependent on transformation coefficient ratio β_{01}/β_{02}. When $\beta_{01} < \beta_{02}$ $(\overline{\beta}_1 > \overline{\beta}_2)$, we get $\overline{\beta}_1\overline{\beta}_2 \le \zeta \le \overline{\beta}_2\,,$ $\overline{\beta}_2 \le \zeta \le \overline{\beta}_1\,,$ $\overline{\beta}_1 \le \zeta \le 1\,.$

In partial intervals, when $\beta_{02} < \beta_{01}$, $\overline{\beta}_1$ alternates with $\overline{\beta}_2$. In particular case, when $\beta_{01} = \beta_{02} = \beta_{0i}$, we get two partial intervals $\overline{\beta}_i^2 \le \zeta \le \overline{\beta}_i\,,$ $\overline{\beta}_i \le \zeta \le 1\,.$

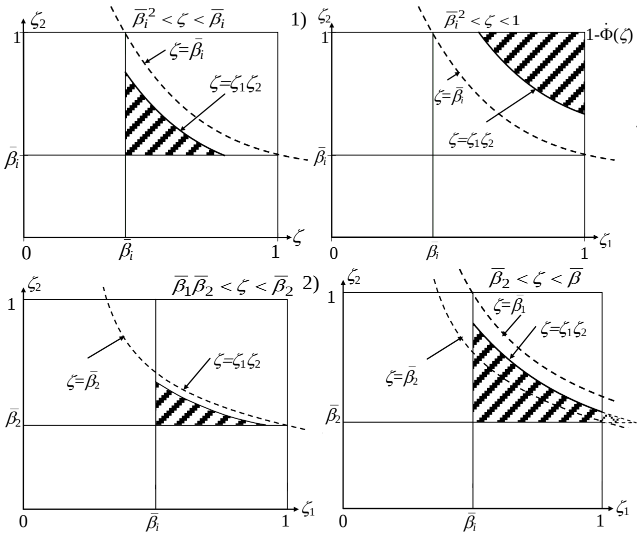

Fig 2. Functions $\dot{\Phi}(\zeta)$ integration ranges: 1) – $\beta_{01} = \beta_{02}$; 2) – $\beta_{01} < \beta_{02}$, ℓ=1

In particular partial intervals, function $\dot{\Phi}(\zeta)$ models are different, dependent on integrate interval (Fig. 2) Functions $\dot{\Phi}(\zeta)$ are expressed using two-dimensional defined integrals.

$$I = I(y_{0i}, y_{1i}) = \int_{y_{01}}^{y_{11}} \int_{y_{02}}^{y_{12}} \dot{\varphi}_1(\zeta_1)\dot{\varphi}_2(\zeta_2) d\zeta_2 d\zeta_1\,, i = 1, 2 \quad (9)$$

Densities $\dot{\varphi}(\zeta)$ are expressed using single-dimensional integral

$$I^* = I^*(y_{01}, y_{11}) = \int_{y_{01}}^{y_{11}} \frac{1}{\zeta_1} \dot{\varphi}_1(\zeta_1)\dot{\varphi}_2\left(\frac{\zeta}{\zeta_1}\right) d\zeta_1\,. \qquad (10)$$

Here $\dot{\varphi}_i(\zeta_i)$– as (5), and integration range depends on β_{01}/β_{02}. Using $y_{01} \le \zeta_1 \le y_{11}$, $y_{02} \le \zeta_2 \le y_{12}$ we get:

1 case: $\beta_{01} = \beta_{02} = \beta_{0i}\,,\ \overline{\beta}_1 = \overline{\beta}_2 = \overline{\beta}_i\,.$

1.1. $\overline{\beta}_i^2 \le \zeta \le \overline{\beta}_i$: $y_{01} = \overline{\beta}_i\,,\ y_{11} = \zeta / \overline{\beta}_i\,;\ y_{02} = \overline{\beta}_i\,;$ $y_{12} = \zeta/\zeta_1$ and $\dot{\Phi}(\zeta) = I\,,\ \dot{\varphi}(\zeta) = I^*$.

1.2. $\overline{\beta}_i \le \zeta \le 1$: $y_{01} = \zeta\,,\ y_{11} = 1;\ y_{02} = \zeta/\zeta_1\,;$ $y_{12} = 1$ and $\dot{\Phi}(\zeta) = 1 - I\,,\ \dot{\varphi}(\zeta) = I^*$.

2 case: $\beta_{01} < \beta_{02},\ \overline{\beta}_1 > \overline{\beta}_2\,.$

2.1. $\overline{\beta}_1\overline{\beta}_2 \le \zeta \le \overline{\beta}_2$: $y_{01} = \overline{\beta}_1,\ \ y_{11} = \zeta/\overline{\beta}_2\,,\ \ y_{02} = \overline{\beta}_2\,;$ $y_{12} = \zeta/\zeta_1\,,\ \dot{\Phi}(\zeta) = I \equiv I_2\,,\ \dot{\varphi}(\zeta) = I^* \equiv I_2^*\,;$

2.2. $\overline{\beta}_2 \le \zeta \le \overline{\beta}_1$: $y_{01}=1$, $y_{11}=\zeta/\overline{\beta}_2$, $y_{02}=\overline{\beta}_2$;

$y_{12}=\zeta/\zeta_1$, $\dot{\Phi}(\zeta)=I_2-I$, $\dot{\varphi}(\zeta)=I_2^*-I^*$;

2.3. $\overline{\beta}_i \le \zeta \le 1$: $y_{01}=\zeta$, $y_{11}=1$, $y_{02}=\zeta/\zeta_1$;

$y_{12}=1$, $\dot{\Phi}(\zeta)=1-I$, $\dot{\varphi}(\zeta)=I^*$.

For further analysis we use only the case when $a_1=a_2=a_i$, $b_1=b_2=b_i$, so the case when $\beta_{02}<\beta_{01}$ equals to the 2nd case. Analyzing the most simple $g_i(\theta_i)$ case [9–15]:

$a_i=b_i=1$, $g_i(\theta_i)=1$, $g(\theta)=-\ln(1-\theta)$.

We get: $\mu_i=1/2$, $\sigma_i^2=1/12$, $\mu=3/4$, $\sigma^2=7/144$;

$$\dot{\varphi}_i(\zeta_i)=h_i(\tau_i)=1/\beta_{01},\ \zeta_i\in(\overline{\beta}_i,1),\ \tau_i\in(0,\beta_{0i});$$

$$I^*=\frac{1}{\beta_{01}\beta_{02}}\int_{y_{01}}^{y_{11}}\frac{d\zeta_1}{\zeta_1}=\frac{1}{\beta_{01}\beta_{02}}\ln\frac{y_{11}}{y_{01}}.$$

Using densities models

1. $\beta_{01}=\beta_{02}=\beta_{0i}$:

$$h(\tau)=\frac{1}{\beta_{0i}^2}\begin{cases}\ln[(1/1-\tau)], & \tau\in(0,\beta_{0i}),\\ \ln\dfrac{1-\tau}{\overline{\beta}_i^2}, & \tau\in(\beta_{0i},\beta_0),\ \beta_0=1-\overline{\beta}_i^2.\end{cases}$$

2. $\beta_{01}<\beta_{02}$:

$$h(\tau)=\frac{1}{\beta_{01}\beta_{02}}\begin{cases}\ln(1-\tau)^{-1}, & \tau\in(0,\beta_{01}),\\ \ln 1/\overline{\beta}_1, & \tau\in(\beta_{01},\beta_{02}),\\ \ln\dfrac{1-\tau}{\overline{\beta}_1\overline{\beta}_2}, & \tau\in(\beta_{02},\beta_0),\ \beta_0=1-\overline{\beta}_1\overline{\beta}_2.\end{cases}$$

In partial case, when $\beta_{02}=1$ (the second parameter is not checked), insert $\overline{\beta}_2=0$ to common models (with $\beta_{01}<\beta_{02}$) and find $h(\tau/\beta_{02}=1),\ \tau\in(0,1)$.

Transformed densities approximations

In the same nonlinear transformation case [1–4], densities $h(\tau)$ are more useful to approximate more simple models for engineering analysis. Using single-parameter model [9-15], we use generalized beta density $h_\sigma(\tau)$

$$h_\sigma(\tau)=\frac{B^{-1}(a^*,b^*)}{\beta_0^{a^*+b^*-1}}\tau^{a^*-1}(\beta_0-\tau)^{b^*-1},\ \tau\in(0,\beta_0)\ ; \quad (11)$$

here

$$a^*=\frac{\mu_\tau}{\beta_0}\left[\frac{\mu_\tau(\beta_0-\mu_\tau)}{\beta_\tau^2}-1\right],\ b^*=\left(\frac{\beta_0}{\mu_\tau}-1\right)a^*$$

and mode

$$\tau_M=\beta_0\frac{a^*-1}{a^*+b^*-2}.$$

With maximum $h_{M\sigma}=h_\sigma(\tau_M)$ valid formulas:

$$\tau_\tau=\beta_0\frac{a^*}{a^*+b^*},\ \sigma_\tau^2=\beta_0=\frac{\mu_\tau\cdot b^*}{(a^*+b^*)(a^*+b^*+1)}. \quad (12)$$

Distribution function $H_\sigma(\tau)$ found using programmed methods.

In partial case, when one of the parameters is not checked, $h_\sigma(\tau)$ becomes beta density, because $\tau\in(0,1)$.

Mathematical realizations, ℓ=2. $a_i=b_i=1$.

1. $\beta_{01}=\beta_{02}=3/8=0{,}375$, $\beta_0=39/64\approx0{,}61$:

$\mu_{\tau_i}=3/16$, $\sigma_{\tau_i}^2=3/256$, $\mu_\tau=0{,}3398$, $\sigma_\tau^2=0{,}01561$,

$a^*=2{,}715$, $b^*=2{,}153$;

$$h(\tau)=\frac{64}{9}\begin{cases}\ln(1-\tau)^{-1}, & \tau\in(0,3/8),\\ \ln\left[\dfrac{64}{25}(1-\tau)\right], & \tau\in(3/8,\ 39/64);\end{cases}$$

$$h_\sigma(\tau)=79{,}7\,\tau^{1{,}715}\left(\frac{39}{64}-\tau\right)^{1{,}153},\ \tau\in(0,39/64);$$

$\tau_{M\sigma}=0{,}364$, $h_{M\sigma}=2{,}787$;

2. $\beta_{01}=1/4$, $\beta_{02}=1/2$, $\beta_0=5/8=0{,}625$:

$\mu_{\tau_1}=1/8$, $\mu_{\tau_2}=1/4$, $\sigma_{\tau_1}^2=1/192$, $\sigma_{\tau_2}^2=1/48$;

$\mu_\tau=11/32=0{,}3438$, $\sigma_\tau^2=0{,}019$;

$a^*=2{,}250$, $b^*=1{,}841$

$$h(\tau)=8\begin{cases}\ln(1-\tau)^{-1}, & \tau\in(0,1/4),\\ \ln 4/3=2{,}302, & \tau\in(1/4,\ 1/2),\\ \ln\left[\dfrac{8}{3}(1-\tau)\right], & \tau\in(1/2,\ 5/8),\end{cases}$$

$$h_\sigma(\tau)=26{,}95\,\tau^{1{,}25}\left(\frac{5}{8}-\tau\right)^{0{,}841},\ \tau\in(0,5/8),$$

$\tau_{M\sigma}=0{,}374$, $h_{M\sigma}=2{,}465$;

3. $\beta_{02}=1$, $\beta_{01}=1/4$, $\tau\in(0,1)$

$\mu_{\tau_2}=\mu_2=1/2$, $\sigma_{\tau_2}^2=\sigma_2^2=1/12$, $\mu_\tau=0{,}5625$,

$\sigma_\tau^2=0{,}06554$, $a^*=1{,}55$, $b^*=1{,}205$;

$$h(\tau/\beta_{02}=1)=4\begin{cases}\ln(1-\tau)^{-1}, & \tau\in(0,1/4),\\ \ln 4/3=1{,}151, & \tau\in(1/4,1),\end{cases}$$

$$h_\sigma(\tau/\beta_{02}=1)=\tau^{0{,}55}(1-\tau)^{0{,}205},\ \tau\in(0,1),$$

$\tau_{M\sigma}=0{,}733$, $h_{M\sigma}=1{,}276$.

Density values for both cases are shown in table 1 and densities are graphically shown in Fig. 3 and Fig. 4.

Table 1. Densities: ℓ=2

Var.	β_{0i}	Density values								
1.1	$\beta_{01}=\beta_{02}=3/8$	τ	0,05	0,15	0,25	0,375	0,45	0,5	0,55	0,6
		$h(\tau)$	0,365	1,156	2,046	3,342	2,433	1,755	1,006	0,169
		$h_\sigma(\tau)$	0,240	1,256	2,273	2,783	2,438	1,893	1,102	0,152
1.2	$\beta_{01}=1/4$ $\beta_{02}=1/2$	$h(\tau)$	0,410	1,300	2,302	2,302	2,302	2,302	1,1459	0,516
		$h_\sigma(\tau)$	0,400	1,345	2,088	2,465	2,293	1,971	1,445	0,640
1.3	$\beta_{02}=1$ $\beta_{01}=1/4$	τ	0,05	0,1	0,2	0,25	0,5	0,9	0,999	1
		$h(\tau)$	0,205	0,421	0,893	1,151	1,151	1,151	1,151	1,151
		$h_\sigma(\tau)$	0,376	0,511	0,778	0,868	1,172	1,173	0,495	0

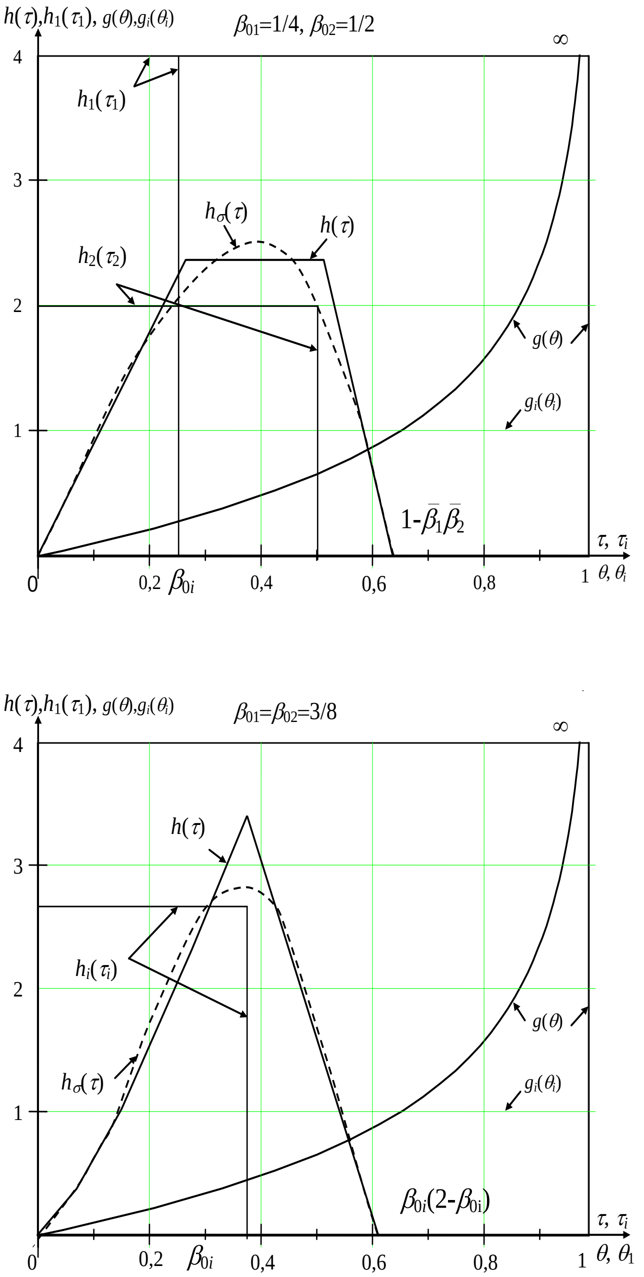

Fig. 3. Two parameters, i=1,2. Densities: $a_i=b_i=1$, $\beta_{01}<\beta_{02}$, $\beta_{01}=\beta_{02}$

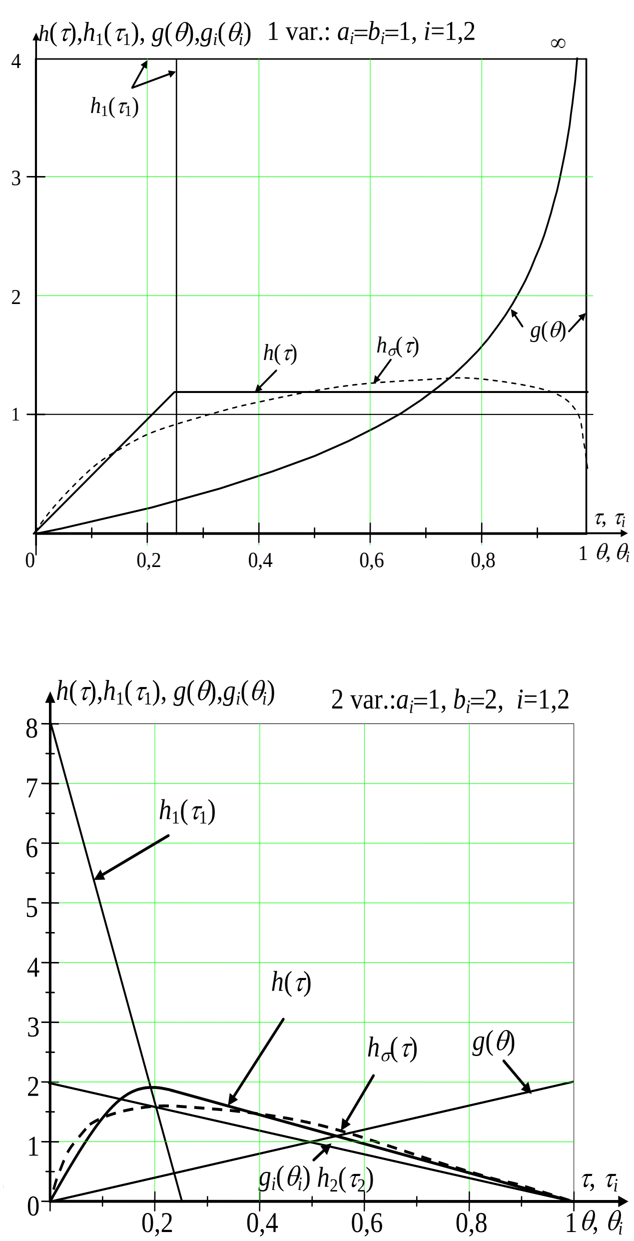

Fig. 4. Two parameters, β_{02}=1. Densities, when β_{01}=1/4

Conclusions

1. It is advisable to use beta densities for different parameters defect level characterization in control system modeling, when linear transformation, also as in nonlinear transformation scheme, is used.
2. Linear transformed defect levels densities by different parameters are more simple than in case of linear transformation, but for all device, especially when parameters are increasing, it becomes more complicated because of integral intervals disjunction to separate intervals where density models become different.
3. If one of the parameters is not checked in the control system, approximated density $h_\sigma(\tau)$ from approximated beta density becomes beta density, because τ variation interval becomes $0 \le \tau \le 1$, when non-checked parameters increase, density $h_\sigma(\tau)$ and also $h(\tau)$ diverges into initial density $g(\theta)$.
4. It is offered to use this modeling technique for engineering projection of control systems with localized repair places.

References

1. **Eidukas D., Kalnius R.** Models Quality of Electronics Products // Electronics and Electrical Engineering. – Kaunas: Technologija, 2010 – No. 2(98). – P. 29–34.
2. **Eidukas D., Kalnius R.** Models of Quality of Mechatronic Products // Electronics and Electrical Engineering. – Kaunas: Technologija, 2009. – No. 7(95) – P. 59–62.
3. **Kalnius R., Eidukas D.**, Reability Model Quality of Informations Systems // Electronics and Electrical Engineering. – Kaunas: Technologija, 2009. – No. 4(92). – P. 13–18.
4. **Eidukas D., Kalnius R.** Multiparameter Electronics Systems Control Probablistic Evaluation // Second International Conference on Advances in Circuits, Electronics and Micro–electronics. – October 11–16, 2009. – Silema, Malta.
5. **Eidukas D., Kalnius R., Vaišvila A.** Probability Distribution Transformation in Continuous Information Systems Control // ITI 2007: proceedings of the 29th international conference on Information Technology Interfaces, June 25–28, 2007, Dubrovnik, Croatia / University of Zagreb. University Computing Centre. Zagreb : University of Zagreb, 2007. – P. 609–614.
6. **Kalnius R., Vaišvila A., Eidukas D.** Probability Distribution Transformation in Continuous Production Control // Electronics and Electrical Engineering. – Kaunas: Technologija, 2006. – No. 4(68). – P. 29–34.
7. **Levitin G.** The Universal Generating Function in Reliability Analysis and Optimization. – Springer. – 2005. – 442 p.
8. **Brogliato B., Lozano R., Maschke B., Egeland O.** Dissipative Systems Analysis and Control Theory and Applications 2nd ed. – Springer. – 2006. – 576 p.
9. **Kalnius R., Eidukas D.** Applications of Generalized Beta–distribution in Quality Control Models // Electronics and Electrical Engineering. – Kaunas: Technologija, 2007. – No. 1(73) – P. 5–12.
10. **Eidukas D., Kalnius R.** Stochastic Models of Quality in Continuous Information Systems // Proceedings of 30 International Conference on Information Technology Interfaces ITI 2008, June 23–26, Cavtat/Dubrovnik, Croatia. – P. 703–708.
11. **Eidukas D.** Stochastic Quality Electronics Systems // Electronics and Electrical Engineering. – Kaunas: Technologija, 2008. – No. 5(85). – P. 41–44.
12. **Caramia M., Dell'Olmo P.** Effective Resource Management in Manufacturing Systems Optimization Algorithms for Production Planning. – Springer. – 2006. – 216 p.
13. **Kruopis J., Vaišvila A., Kalnius R.** Mechatronikos gaminių kokybė. Vilnius: Vilniaus universiteto leidykla, 2005. – 518 p.
14. **Eidukas D., Kalnius R.** Stochastic Models of Quality Level of Mechatronic Products // Electronics and Electrical Engineering. – Kaunas: Technologija, 2008. – No. 3(83). – P. 43–48.
15. **Murthy D. N. P., Blischke W. R.** Warranty Management and Product Manufacture. – Springer. – 2006. – 302 p.

Received 2010 04 02

D. Eidukas, R. Kalnius. Two-Parameter Electronic Devices Quality Models // Electronics and Electrical Engineering. – Kaunas: Technologija, 2010. – No. 7(103). – P. 3–8.

Continuous control main probability characteristic modeling methods for multiparameter electronics devices has been made, when separate independent device parameters defect level probabilistic distributions are “a priori” known. Defected devices flow in control operation is targeted to localized repair operation in this stage, then devices with second type errors goes again into control and “rotates” until all devices are accepted as good. Second type classification errors probabilities (defect device is accepted as good) in control and repair operations are described by one generalized error model, which is used in linear defect level transformation by different parameters. For all device defect level transformation, defect level transformation by different parameters is used. For all defect level transformation, defect levels densities by different parameters combination, is used referencing by transformation model. It is offered to use approximated models instead of exact whole device defect level probabilistic density by different parameters, described by beta law density, because it is the whole model and the exact defect level density is expressed by many different models in every partial interval of integration. This method simplifies modeling procedure, without decreasing engineering analysis accuracy. Ill. 4, bibl. 15, tabl. 1 (in English; abstracts in English, Russian and Lithuanian).

Д. Эйдукас, Р. Кальнюс. Модели линейной трансформации уровня качества многопараметрических изделий // Электроника и электротехника. – Каунас: Технология, 2010. – № 7(103). – С. 3–8.

Предложена методика моделирования основных вероятностных характеристик системы сплошного контроля многопараметрических мехатронных изделий, когда “априори“ известны вероятностные распределения уровней дефектности отдельных независимых параметров. Поток забракованных изделий после контроля возвращается на локализированную для данного этапа операцию ремонта, после которой отремонтированные изделия повторно направляются на контроль при наличии ошибки второго рода (дефектное изделие признаётся годным) и повторно проходит весь цикл, пока все забракованные и отремонтированные изделия на контроле признаются годными. Вероятности ошибок второго рода на операциях контроля и ремонта описываются объединенной моделью обобщенной ошибки второго рода, которая используется для линейной трансформации уровня дефектности на контроле по отдельным параметрам. Для трансформации уровня дефектности всего изделия применяется объединение плотностей вероятностей по отдельным параметрам на основе модели трансформации. Предложено вместо точной модели трансформации для всего изделия использовать аппроксимированные модели плотностей вероятностей трансформированных уровней дефектности на основе плотности вероятности обобщенного бета распределения, так как это единая модель (без разрывов на локальных интервалах интегрирования). Это значительно упрощает моделирование, при этом не уменьшая точность результатов инженерного анализа. Ил. 4, библ. 15, табл. 1 (на английском языке; рефераты на английском, русском и литовском яз.).

D. Eidukas, R. Kalnius. Daugiaparametrių gaminių kokybės lygio tiesinės transformacijos modeliai // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2010. – Nr. 7(103). – P. 3–8.

Sudaryta daugiaparametrių mechatroninių gaminių ištisinės kontrolės pagrindinių tikimybių charakteristikų modeliavimo metodika, kai atskirų nepriklausomų gaminio parametrų defektingumo lygių tikimybiniai skirstiniai yra aprioriškai žinomi. Išbrokuotų gaminių srautas po kontrolės operacijos yra nukreipiamas į šio etapo lokalizuotą remonto operaciją, po kurios gaminiai su antros rūšies klaida vėl patenka į kontrolę ir pakartotinai „sukasi“ tol, kol visi gaminiai pripažįstami gerais. Antros rūšies klasifikavimo klaidų tikimybės (defektinis gaminys pripažįstamas geru) kontrolės ir remonto operacijose išreiškiamos vienu apibendrintos klaidos modeliu, kuris taikomas tiesinei defektingumo lygių transformacijai pagal atskirus parametrus. Viso gaminio defektingumo lygio transformacijai taikomas defektingumo lygių tankių pagal atskirus parametrus sujungimas, remiantis transformacijos modeliu. Pasiūlyta vietoj tikslių viso gaminio defektingumo lygio tikimybių tankio transformuotų modelių taikyti aproksimuotus modelius, išreiškiamus apibendrinto beta dėsnio tankiu, nes tai vientisas modelis, o tikslus defektingumo lygio tankis išreiškiamas keletu skirtingų modelių kiekviename integravimo rėžių daliniame intervale. Tai gerokai supaprastina modeliavimo procedūrą, o inžinerinės analizės rezultatų tikslumas nesumažėja. Il. 4, bibl. 15, lent. 1 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).