REGRESSIYA KOEFFITSIENTLARINI BAHOLASH FORMULALARINI MATRITSASIZ YONDASHUVDA ENG KICHIK KVADRATLAR METODI BILAN KELTIRIB CHIQARISH

Abdullayev Xakim Olimjanovich
Namangan muhandislik-texnologiya instituti,
dotsent, fizika-matematika fanlari nomzodi.
hakim-olim@mail.ru +998 90 554 97 88

Texnologik jarayonlarni avtomatlashtirish va boshqarishga oid tadqiqotlarda asosan uchta masalaga duch kelinadi: analiz, sintez va identifikatsiylash [1, 2, 3]. Identifikatsiyalash masalasini yechishda eksperimental tadqiqotlar eng yuqori shakldagi empirik metod hisoblanadi va texnologik qurilmalarni modellashtirishda eksperiment natijalarini analiz va qayta ishlashga, ular asosida empirik modellar qurish masalasiga duch kelinadi. Empirik modellarni esa o`z navbatida regression analiz metodlari bilan quriladi. Regressiya –bitta korrelyatsiyalanadigan belgining kattaligi bo`yicha boshqa belgining o`rtacha kattaligini aniqlashga imkon beruvchi funktsiya. Regressiyaning eng sodda modeli - chiziqli regressiyani qarab chiqamiz. Chiziqli regressiyada $y_x = a + b \cdot x$ ko`rinishdagi tenglama berilgan x faktorning qiymatlari bo`yicha natijaviy belgining nazariy qiymatlarini topishga imkon beradi.

Masalaning qo`yilishi

Kuzatishlarning to`rt jufti uchun faktor va javobning qiymatlari ma’lum bo`lsin, deb faraz qilaylik (belgilashlar Jadval 1 da taqdim etilgan)

Jadval 1

i	$\mathbf{y_i}$	$\mathbf{x_i}$
1	y_1	x_1
2	y_2	x_2
3	y_3	x_3
4	y_4	x_4

Bog`liq o`zgaruvchi (javob) lar y_1, y_2, y_3, y_4 va faktorlar x_1, x_2, x_3, x_4 (regressorlar, erkin o`zgaruvchilar) o`rasidagi bog`liqlikni tadqiqotchi quyidagi ko`rinishda faraz qilgan bo`lsin:

$$y_1 = a + bx_1 + \varepsilon_1$$
$$y_2 = a + bx_2 + \varepsilon_2$$
$$y_3 = a + bx_3 + \varepsilon_3$$
$$y_4 = a + bx_4 + \varepsilon_1$$

yoki

$$\mathbf{y_i} = a + b\mathbf{x_i} + \boldsymbol{\varepsilon}_\mathbf{i}$$

bu yerda **i** – kuzatishlar juftining nomeri, $\mathbf{y_i}$ – kuzatishlarning **i** – juftiga mos keluvchi javob, $\mathbf{x_i}$ – kuzatishlarning **i** – juftiga mos keluvchi faktorning qiymati, $\boldsymbol{\varepsilon}_\mathbf{i}$ – kuzatishlarning **i** – juftiga mos keluvchi tasodifiy xatolik. $\mathbf{y_i} = a + b\mathbf{x_i} + \boldsymbol{\varepsilon}_\mathbf{i}$ ko`rinishdagi tenglama berilgan $\mathbf{x_i}$ faktorning qiymatlari bo`yicha natijaviy belgi $\mathbf{y_i}$ ning nazariy qiymatlarini topishga imkon beradi.

Chiziqli regressiyaning parametrlarini baholashga bo`lgan klassik yondashuv eng kichik kvadratlar metodi (EKKM) ga asoslangan, bu metod $a$ va $b$ parametrlarning shunday baholanishlarini olishga imkon beradiki, parametrlarning bu qiymatlarida natijaviy belgi $\mathbf{y_i}$ ni faktli qiymatlarini nazariy qiymatlari $a + b\mathbf{x_i}$ dan og`ishlarining kvadratlarini yig`indisi minimal bo`ladi, yani:

$$\sum_{i=1}^{n}(\mathbf{y_i}-a-b\mathbf{x_i})^2=\sum_{i=1}^{n}\boldsymbol{\varepsilon}_i^2\rightarrow min. \qquad (1)$$

Shunday qilib, hamma chiziqlar to`plami ichidan regressiya chizig`ini grafikda shunday tanlanadiki, nuqtalar va bu chiziq orasidagi vertikal bo`yicha masofalar kvadratlarining yig`indisi minimal bo`lsin.

Masalani yechish metodi. Matematik analiz kursidan ma'lumki, funktsiya (1) ning minimumini topish uchun, a va b parametrlarning har biri bo`yicha xususiy hosilalarni hisoblash va bu hosilalarni nolga tenglash zarur.

EKKM ga muvofiq regressiya koeffitsientlari **a** va **b** larni baholash formulalarini ikkita tenglamalar sistemasini yechish bilan keltirib chiqariladi, ulardan har biri $\boldsymbol{\varepsilon}_\mathbf{i}$ ning kvadratlari yig`indisining **a** va **b** koeffitsientlar bo`yicha hosilalarining nolga tengligini aks ettiradi [4, 5, 6].

Hisoblashlar.

$\sum_{i=1}^{n}\varepsilon_i^2$ ni $S(a,b)$ bilan belgilaymiz: $S(a,b)=\sum_{i=1}^{n}(y_i-a-bx_i)^2$ ga ega bo`lamiz.$(\mathbf{y_i}-a-b\mathbf{xi})2$ ni $(c-d)2=c2-2cd+d2$ ayniyat bo`yicha hisoblaymiz:

$$S(a,b)=\sum_{i=1}^{n}(\mathbf{y_i}-a-b\mathbf{x_i})^2=\sum_{i=1}^{n}[(\mathbf{y_i}-a)-b\mathbf{x_i}]^{\mathbf{2}}=$$

$$=\sum_{i=1}^{n}\left[(\mathbf{y_i}-a)^{\mathbf{2}}-2(\mathbf{y_i}-a)b\mathbf{x_i}+b^2\mathbf{x}_i^2\right]==\sum_{i=1}^{n}(\mathbf{y_i}-a)^{\mathbf{2}}-2\mathbf{y_i}b\mathbf{x_i}+2ab\mathbf{x_i}+b^2\mathbf{x}_i^2=$$

$$=\sum_{i=1}^{n}\left(\boldsymbol{y}_i^{\mathbf{2}}-2\mathbf{y_i}a+a^2-2\mathbf{y_i}b\mathbf{x_i}+2ab\mathbf{x_i}+b^2\mathbf{x}_i^2\right).$$

Ushbuga ega bo`lamiz:

$$S(a,b)=\sum_{i=1}^{n}\left(y_i^2-2\mathbf{y_i}a+a^2-2\mathbf{y_i}b\mathbf{x_i}+2ab\mathbf{x_i}+b^2\mathbf{x}_i^2\right).$$

$S(a,b)$ dan **a** va **b** koeffitsientlar bo`yicha hosilalarni olamiz va ularni nolga tenglaymiz:

$$\frac{\partial S}{\partial a}=\sum_{i=1}^{n}(-2\mathbf{y_i}+2\mathrm{a}+2b\mathbf{x_i}).$$

$$\frac{\partial S}{\partial b}=\sum_{i=1}^{n}\left(-2\mathbf{y_i}\mathbf{x_i}+2\mathrm{a}\mathbf{x_i}+\mathbf{2}b\mathbf{x}_i^2\right).$$

Natijada quyidagi sistemaga ega bo`lamiz:

$$\begin{cases}\dfrac{\partial S}{\partial a}=-2\sum_{i=1}^{n}(\mathbf{y_i}-\mathrm{a}-b\mathbf{x_i})=0;\\ \dfrac{\partial S}{\partial b}=-2\sum_{i=1}^{n}\mathbf{x_i}(\mathbf{y_i}-\mathrm{a}\mathbf{x_i}-b\mathbf{x_i})=0.\end{cases}$$

Murakkab bo`lmagan almashtirishlardan so`ng, a va b parametrlarni baholash uchun quyidagi chiziqli tenglamalar sistemasini olamiz:

$$\begin{cases}-2\sum_{i=1}^{n}(\mathbf{y_i}-\mathrm{a}-b\mathbf{x_i})=0;\\ -2\sum_{i=1}^{n}\mathbf{x_i}(\mathbf{y_i}-\mathrm{a}\mathbf{x_i}-b\mathbf{x_i})=0.\end{cases}$$

$$\begin{cases}\sum_{i=1}^{n}(\mathbf{y_i}-\mathrm{a}-b\mathbf{x_i})=0;\\ \sum_{i=1}^{n}\mathbf{x_i}(\mathbf{y_i}-\mathrm{a}\mathbf{x_i}-b\mathbf{x_i})=0.\end{cases}$$

$$\begin{cases} \sum_{i=1}^{n} \mathbf{y_i} - an - b\sum_{i=1}^{n} \mathbf{x_i} = 0; \\ \sum_{i=1}^{n} \mathbf{x_i}\mathbf{y_i} - a\sum_{i=1}^{n} \mathbf{x_i} - b\sum_{i=1}^{n} \mathbf{x}_i^2 = 0. \end{cases}$$

Sistemaning ikkinchi (pastki) tenglamasidan **b** koeffitsientni baholash formulasini keltirib chiqaramiz, avval sistemaning birinchi tenglamasidan a ni ifodalab olish zarur:

$$\begin{cases} \sum_{i=1}^{n} \mathbf{y_i} - b\sum_{i=1}^{n} \mathbf{x_i} = an; \\ \sum_{i=1}^{n} \mathbf{x_i}\mathbf{y_i} - a\sum_{i=1}^{n} \mathbf{x_i} - b\sum_{i=1}^{n} \mathbf{x}_i^2 = 0. \end{cases}$$

$$\begin{cases} a = \frac{\sum_{i=1}^{n} \mathbf{y_i}}{n} - \frac{b\sum_{i=1}^{n} \mathbf{x_i}}{n} \\ \sum_{i=1}^{n} \mathbf{x_i}\mathbf{y_i} - a\sum_{i=1}^{n} \mathbf{x_i} - b\sum_{i=1}^{n} \mathbf{x}_i^2 = 0. \end{cases}$$

$$\begin{cases} a = \frac{\sum_{i=1}^{n} \mathbf{y_i}}{n} - \frac{b\sum_{i=1}^{n} \mathbf{x_i}}{n}; \\ \sum_{i=1}^{n} \mathbf{x_i}\mathbf{y_i} - \left(\frac{\sum_{i=1}^{n} \mathbf{y_i}}{n} - \frac{b\sum_{i=1}^{n} \mathbf{x_i}}{n}\right)\left(\sum_{i=1}^{n} \mathbf{x_i}\right) - b\sum_{i=1}^{n} \mathbf{x}_i^2 = 0. \end{cases}$$

$$\begin{cases} a = \frac{\sum_{i=1}^{n} \mathbf{y_i}}{n} - \frac{b\sum_{i=1}^{n} \mathbf{x_i}}{n}; \\ \sum_{i=1}^{n} (\mathbf{x_i} * \mathbf{y_i}) - b\sum_{i=1}^{n} \mathbf{x}_i^2 - \frac{\sum_{i=1}^{n} \mathbf{y_i}(\sum_{i=1}^{n} \mathbf{x_i})}{n} + \frac{b\sum_{i=1}^{n} \mathbf{x_i}(\sum_{i=1}^{n} \mathbf{x_i})}{n} = 0. \end{cases}$$

$$-b\left(\frac{\sum_{i=1}^{n} \mathbf{x_i} \sum_{i=1}^{n} \mathbf{x_i}}{n} - \sum_{i=1}^{n} \mathbf{x}_i^2\right) = \frac{\sum_{i=1}^{n} \mathbf{y_i} \sum_{i=1}^{n} \mathbf{x_i}}{n} - \sum_{i=1}^{n} (\mathbf{x_i} * \mathbf{y_i})$$

Belgilashlar:

$$\frac{\sum_{i=1}^{n} \mathbf{y_i} \sum_{i=1}^{n} \mathbf{x_i}}{n} = \bar{x}\bar{y}, \sum_{i=1}^{n} \mathbf{y_i} \sum_{i=1}^{n} \mathbf{x_i} = n\bar{x} * \bar{y}.$$

$$\frac{\sum_{i=1}^{n} \mathbf{x_i} \sum_{i=1}^{n} \mathbf{x_i}}{n} = \bar{x}^2, \sum_{i=1}^{n} \mathbf{x_i} \sum_{i=1}^{n} \mathbf{x_i} = n\bar{x}^2,$$

$$-b\left(n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2\right) = n\bar{x} * \bar{y} - \sum_{i=1}^{n} (x_i * y_i)$$

$$\hat{b} = -\frac{n\bar{x} * \bar{y} - \sum_{i=1}^{n} (x_i * y_i)}{n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2}$$

Oxirgi ifodani surat va maxrajini n ga bo`lamiz:

$$\hat{b} = -\frac{\frac{\sum_{i=1}^{n} \mathbf{x_i}\mathbf{y_i} - n\bar{x}\bar{y}}{n}}{\left(\frac{n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2}{n}\right)} = -\frac{\frac{\sum_{i=1}^{n} \mathbf{x_i}\mathbf{y_i}}{n} - \bar{x}\bar{y}}{\left(\bar{x}^2 - \frac{\sum_{i=1}^{n} \mathbf{x}_i^2}{n}\right)}$$

$$\hat{b} = -\frac{\frac{\sum_{i=1}^{n} \mathbf{x_i}\mathbf{y_i}}{n} - \bar{x}\bar{y}}{\left(\bar{x}^2 - \frac{\sum_{i=1}^{n} \mathbf{x}_i^2}{n}\right)} = -\frac{\overline{xy} - \bar{x}\bar{y}}{\left(\bar{x}^2 - \frac{\sum_{i=1}^{n} \mathbf{x}_i^2}{n}\right)} = \frac{\bar{x} * \bar{y} - \overline{xy}}{\left(\bar{x}^2 - \frac{\sum_{i=1}^{n} \mathbf{x}_i^2}{n}\right)}.$$

$$\hat{b} = \frac{\bar{x} * \bar{y} - \overline{xy}}{\left(\bar{x}^2 - \frac{\sum_{i=1}^{n} \mathbf{x}_i^2}{n}\right)}.$$

b koeffitsient baholanishini sistemaning birinchi tenglamasiga qo`yamiz va a koeffitsient baholanishini topamiz:

$$a = \frac{\sum_{i=1}^{n} \mathbf{y_i}}{n} - \frac{b\sum_{i=1}^{n} \mathbf{x_i}}{n}, \qquad \frac{\sum_{i=1}^{n} \mathbf{y_i}}{n} = \bar{y}; \quad \hat{a} = \bar{y} - \frac{b\sum_{i=1}^{n} \mathbf{x_i}}{n},$$

$$\hat{a} = \bar{y} - \sum_{i=1}^{n} \mathbf{x_i} \frac{\frac{\bar{x} * \bar{y} - \overline{xy}}{\left(\bar{x}^2 - \frac{\sum_{i=1}^{n} \mathbf{x}_i^2}{n}\right)}}{n}, \qquad \bar{x}^2 - \frac{\sum_{i=1}^{n} \mathbf{x}_i^2}{n} = \frac{n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2}{n},$$

$$\frac{\bar{x}\bar{y} - \overline{xy}}{\left(\bar{x}^2 - \frac{\sum_{i=1}^{n} \mathbf{x}_i^2}{n}\right)} = \frac{\bar{x}\bar{y} - \overline{xy}}{\frac{n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2}{n}} = \frac{n(\bar{x}\bar{y} - \overline{xy})}{n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2},$$

$$\hat{a} = \bar{y} - \sum_{i=1}^{n} \mathbf{x_i} \frac{\bar{x} * \bar{y} - \overline{xy}}{n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2}.$$

$$\hat{a} = \bar{y} - \sum_{i=1}^{n} \mathbf{x_i} \frac{\bar{x} * \bar{y} - \overline{xy}}{n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2} = \frac{\bar{y}n\bar{x}^2 - \bar{y}\sum_{i=1}^{n} \mathbf{x}_i^2}{n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2} - \sum_{i=1}^{n} \mathbf{x_i} \frac{\bar{x} * \bar{y} - \overline{xy}}{n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2} =$$

$$= \frac{\bar{y}n\bar{x}^2 - \bar{y}\sum_{i=1}^{n} \mathbf{x}_i^2 - \bar{x} * \bar{y}\sum_{i=1}^{n} \mathbf{x_i} + \sum_{i=1}^{n} \mathbf{x_i} * \overline{xy}}{n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2} =$$

$$= \frac{\bar{y}n\bar{x}^2 - \bar{y}\sum_{i=1}^{n} \mathbf{x}_i^2 - \bar{y}n\bar{x}^2 + \sum_{i=1}^{n} \mathbf{x_i} * \overline{xy}}{n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2}.$$

$$\hat{a} = \frac{-\bar{y}\sum_{i=1}^{n} \mathbf{x}_i^2 + \sum_{i=1}^{n} \mathbf{x_i} * \overline{xy}}{n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2}.$$

Olingan natija.

$$\hat{a} = \frac{-\bar{y}\sum_{i=1}^{n} \mathbf{x}_i^2 + \sum_{i=1}^{n} \mathbf{x_i} * \overline{xy}}{n\bar{x}^2 - \sum_{i=1}^{n} \mathbf{x}_i^2}.$$

$$\hat{b} = \frac{\bar{x} * \bar{y} - \overline{xy}}{\left(\bar{x}^2 - \frac{\sum_{i=1}^{n} \mathbf{x}_i^2}{n}\right)}.$$

ADABIYOTLAR

1. Abdullayev H.O.,Qodirov D.T., Avtomatik boshqarish sistemasi, Namangan: FAZILAT ORGTEX SERVIS, 2022,248 b.
2. Abdullayev H.O., Optimal va adaptiv boshqarish sistemalari, Namangan: USMON NOSIR MEDIA, 2023. 120 b.
3. Abdullayev X.O., Toshpo`latov Q.Ya., "Korrektlovchi qurilmalarni analogli modellashtirish," in Iqtisodiyot tarmoqlari va ijtimoiy sohaning energiya samaradorligini oshirishga qaratilgan avtomatlashtirish va energetika muammolarni yechishda ilg`or innovatsion texnologiyalarda ta'limni o`rni, Namangan, 2021.
4. X.O.Abdullayev. Algorithm for drawing up structured schemes of automatic control systems // Web of Technology: Multidimensional Research Journal. 2024. Volume 2, Issue 11. pp.229-239

5. Anvarovich, A. A. (2023). The importance of the MQ-2 sensor in fire detection. *International journal of advanced research in education, technology and management*, *2*(6).
6. Ruzimatov, S., & Azizbek, A. (2021). Management of production resources of the enterprise Improving the algorithmic model of information-analytical support of the process. *Texas Journal of Multidisciplinary Studies*, *3*, 252-256.
7. Anvarovich, A. A. (2022). Mikroprotsessorni boshqarish va ma'lumotlarni qayta qilish birligini tuzilik va asosiy diagramasini ishlab chiqish. *Journal of new century innovations*, *19*(2), 107-113.
8. Аскаров, А. А. (2023). Роль метода нечеткой логики при обнаружении пожаров на производстве. *Лучшие интеллектуальные исследования*, *10*(3), 126-130.
9. А.О. Дедаханов. Основные факторы, влияющие на технологию сушки хлопка // "Экономика и социум", № 10 (113)-2, 2023. Ст. 552-555.
10. 5. А.О. Дедаханов. Распределение влаги в процессе сушки хлопкового сырья // International Scientific Research Conference, том-3б №27. 2024, ст.16-19.
11. R.G. Rakhimov. Clean the cotton from small impurities and establish optimal parameters // The Peerian Journal. Vol. 17, pp.57-63 (2023)
12. N. Sharibaev, A. Jabborov, R. Rakhimov, Sh. Korabayev, R. Sapayev. A new method for digital processing cardio signals using the wavelet function // BIO Web of Conferences. 2024. Vol. 130, Article ID 04008.
13. R.G. Rakhimov. The advantages of innovative and pedagogical approaches in the education system // Scientific-technical journal of NamIET. Vol. 5, Iss. 3, pp.293-297 (2023)
14. R.G. Raximov, M.A. Azamov. Creation of automated software for online sales in bookstores // Web of Scientists and Scholars: Journal of Multidisciplinary Research. Vol. 2, Iss. 6, pp.42-55 (2024)
15. R.G. Raximov, M.A. Azamov. Technology for creating an electronic tutorial // Web of Scientists and Scholars: Journal of Multidisciplinary Research. Vol. 2, Iss.6, pp.56-64 (2024)
16. R.G. Rakhimov, A.A. Juraev. Designing of computer network in Cisco Packet Tracer software // The Peerian Journal. Vol. 31, pp.34-50 (2024)
17. R.G. Rakhimov, E.D. Turonboev. Using educational electronic software in the educational process and their importance // The Peerian Journal. Vol. 31, pp.51-61 (2024)
18. Y.A.Valijon o'g'li, J.E.Shavkat o'g'li, S.H.Hakimjon o'g'li, M.F.Farxod o'g'li. (2023). Sun'iy intellektda bilimlarni tasvirlash modellari. *Tadqiqotlar.uz*, *28*(5), 22-30.

19.Y.A.Valijon o‘g‘li, N.Y.Saydulla o‘g‘li, N.S.Shavkat o’g’li, X.S.Ubaydulla o'g'li. (2023). Fuzzy moduli yordamida noqat’iy boshqarish sistemalarni qurish. *Tadqiqotlar.uz*, *28*(5), 31-37.
20.Y.A.Valijon o‘g‘li, X.R.Davlat o‘g‘li, G.A.Tirkash o‘gli. (2023). Fuzzy logic yordamida sistemani sugeno tipida loyihalash. *Journal of new century innovations*, *43*(2), 97-106.
21.Yo‘ldashev A. V. (2024). Ob’yekt holatlarini tashxislashning intellektual modelini shakllantirish tamoyili. *Экономика и социум*, (3-2 (118)), 436-440.
22. Yoqubjanov A. Ekspert tizimining tuzilishi va hususiyatlari // Interpretation and researches. 2024. Vol. 11, Iss.33, pp.59-65.
23.Ёкубжанов А. Роль автоматизации в повышении эффективности технологических процессов // Новости образования: исследование в XXI веке. Vol. 1, Iss. 12, pp.51-54.
24. A.O.Yoqubjanov, Sh.T.Toshqulov. Improving product manufacturing efficiency by enhancing the working parts of sorting robot manipulators // Web of Technology: Multidimensional Research Journal. 2024. Volume 2, Issue 11. pp.283-290
25.R.G. Rakhimov. Clean the cotton from small impurities and establish optimal parameters // The Peerian Journal. Vol. 17, pp.57-63 (2023)
26.Жураев, А. Д., Холмирзаев, Ж. З., & Хайдаров, Б. А. Ў. (2022). Разработка эффективной конструктивной схемы колосников на упругих опорах и оптимизация параметров очистителя хлопка. Механика и технология, (Спецвыпуск 2), 9-15 betlar.
27.Haydarov Bahtiyor Abdullajon o’g’li. "Paxtani mayda chiqindilardan tozalash jarayonida ko ‘p qirali qoziqcha tayyorlangan qoziqchalarning paxta sifat ko ‘rsatkichlariga ta’sirini o ‘rganish." Journal of new century innovations 19.2 (2022): 137-141 betlar.
28.Haydarov Bahtiyor. "Takomillashtirilgan qoziqli baraban mayda ifloslik tarkibiga ta'sirini tahlil qilish." Ijodkor o'qituvchi 2.20 (2022): 7-9 betlar.
29.Djuraev, A., Sayitkulov, S., Rajabov, O., Kholmirzaev, J., & Haydarov, B. (2022, December). Analysis of the impact effect of a piece of cotton with a flat surface with a multi-sided grates slope. In *Journal of Physics: Conference Series* (Vol. 2373, No. 2, p. 022048). IOP Publishing.
30.Д.Т.Қодиров, Н.М.Икромжонова, С.М.Холдоралиев. Кечикишли динамик объектларни бошқаришда мунтазам идентификациялаш алгоритмлари. Namangan muhandislik-texnologiya instituti “Yarimo‘tkazgichlar fizikasining fundamental va amaliy muammolari: yechimlari va istiqbollari” mavzusidagi xalqaro ilmiy-amaliy konferensiya materiallari. 351-бет.

31. Д.Т.Қодиров, Н.М.Икромжонова, С.М.Холдоралиев. Кечикишли объектларни чизиқли бошқариш системасини адаптив синтезлаш алгоритмлари. Namangan muhandislik-texnologiya instituti "Yarimo'tkazgichlar fizikasining fundamental va amaliy muammolari: yechimlari va istiqbollari" mavzusidagi xalqaro ilmiy-amaliy konferensiya materiallari. 356-бет.
32. D.T.Qodirov, N.Ikromjonova. On delayed technological objects and their characteristics. Наманган мухандислик технология институти илмий техника журнали. Наманган – 2024 й.
33. Кодиров Д.Т. Алгоритмы устойчивого многошагового оценивания состояния нелинейных стохастических систем // Международный научно-технический журнал «Химическая технология. Контроль и управление». Ташкент, ТашГТУ. №5, 2017. -С.66-71.
34. Sh. Djuraev, D. To'xtasinov. Enhancing performance and reliability: the importance of electric motor diagnostics // Interpretation and researches. 2023. Vol.1, Iss.10
35. Sharibaev N.Yu., Djuraev Sh.S., Toxtasinov D.X. Priorities in determining electric motor vibration with ADXL345 accelerometer sensor // Al-Farg'oniy avlodlari. 2023. Vol.1, Iss.4, pp.226-230
36. А.А.Мамаханов, Ш.С.Джураев, Н.Ю.Шарибаев, М.Э.Тулкинов, Д.Х.Тухтасинов. Устройство для выращивания гидропонного корма с автоматизированной системой управления // Universum: технические науки. 2020. No 8-2 (77), pp.17-2
37. D. To'xtasinov. Mathematical model of the relationship between the vibration of the electric motor and the defect in the bearing // Interpretation and researches. 2024. Vol. 2, Iss. 11, pp.75- 78
38. Abdusamat K., Mamatovich A. S., Muhammadziyo I. Mathematical Modeling of the Technological Processes Original Processing of Cotton //International Journal of Innovation and Applied Studies. – 2014. – Т. 6. – №. 1. – С. 28.
39. Mardonov B., Tadaeva Y., Muhammadziyo I. Experimental and theoretical studies of vibrational motion of raw cotton on inclined mesh surface //International Journal of Innovation and Scientific Research. – 2014. – Т. 9. – С. 78-85.
40. Karimov A. I., Ismanov M. Mathematical Modeling of Heat Flux Distribution in Raw Cotton Stored in Bunt //Engineering. – 2020. – Т. 12. – №. 08. – С. 591-599.
41. Muhammadziyo I. Research Of Characteristics And Analysis Of Calculations Of Optoelectronic Hydrometers Of Automatic Control //Solid State Technology. – 2020. – Т. 63. – №. 6. – С. 14910-14916.

42. N. Parpiyeva. Automatic control system of pressing equipment parameters // Ethiopian International Journal of Multidisciplinary Research. 2024. Vol.11, Iss,3, pp.147-153
43. Х. Парпиев, А.Б. Гафуров, П.Д. Ласточкин, Н.Х. Парпиева. Прочная супергидрофобная хлопчатобумажная ткань для фильтрации масляно-водяных смесей //Технология текстильной промышленности. 2023, № 2 (404), pp.83-91
44. Nilufar Parpiyeva, & Abdulahadov Abduhalil Abduvali o'g'li. Checking the three-phase asynchronous motor connected to the network in the star and delta method. Web of Technology: Multidimensional Research Journal, 2024. 2(11), 275–282.
45. А.Н.Шарибаев, Р.Н.Шарибаев, Б.Т.Абдулазизов, М.Р.Тохиржонова. Проблемы в области глубокого обучения с подкреплением // Форум молодых ученых. 2023. Vol.6, Iss.82, pp.420-422
46. E.Sharibaev, O.Sarimsakov, R.Sharifbaev. Process monitoring of devil machine electric engine in cotton primary processing enterprises // AIP Conference Proceedings. 2023. Vol.2700, Iss.1, 050024
47. Р.Н.Шарибаев, Ш.С.Джураев, М.Р.Тохиржонова. Улучшение классификации по сортам коконов с использованием сверточных нейронных сетей // Теория и практика современной науки. 2023. Vol. 6, Iss.96, pp.212-214.
48. Р.Н.Шарибаев, Р.Н.Шарифбаев, С.С.Шарипбаев. Задача полупроводниковых датчиков в мехатронных системах // International Conference on World Science and Resarch. 2024. Vol.1, Iss.2, pp.5-8. Volume 2, Issue 11, November 2024 ISSN (E): 2938-375