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TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university

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Articles are published in Uzbek, Russian, and English, ensuring a wide-reaching audience and fostering cross-cultural academic exchange. As a beacon of academic excellence, the "Journal of Transport" continues to serve as a vital conduit for knowledge dissemination, collaboration, and innovation in the transport sector and related fields.

Versus the repeated maneuver route relay circuit analysis and model

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Abstract: The article analyzes the question of the replacement of electromagnetic relays of railway automation and telemechanics with microelectronic devices that exist in practice. Currently, information technology and microelectronic devices are one of the most dynamically developing industries in the modern world, and now play an important role in the processing of information resources around the world and the exchange of information between the device and users. The hardware supply structure of these systems is enriched by a new integrated circuit and equipment Day by day, in exchange for the rapid development of semiconductor technology. In such conditions, by improving safety and optimizing the information provided about its current state, issues of improving the efficiency and reliability of railway station devices, monitoring the condition, the devices of the control systems of automation and telemechanics in rail transport are analyzed. To achieve these goals, the following must be carried out these; the introduction of digital methods of information processing, the implementation of current control, the improvement of data processing, the replacement of electromagnetic relays with microelectronic devices, which is one of the important elements of automation and telemechanics devices. This article proposes a model using Petri theory to overcome the above-mentioned ventricles and achieve a number of goals set. Also based on the results of the simulation, algorithms have been developed for model, and reflection methods and results have been determined through model.

Keywords: railway transport, electromagnetic relays, graph theory, modeling

Manevr marshrutining takrorlanishga qarshi rele zanjirining tahlili va modeli

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Annotatsiya: Maqolada temir yo‘l avtomatikasi va telemexanikasining amalda mavjud bo‘lgan elektromagnit relelarni mikroelektron qurilmalar bilan almashtirish masalasi tahlil qilingan. Hozirgi kunda axborot texnologiyalari va mikroelektron qurilmalar zamonaviy dunyoda eng jadal rivojlanayotgan sohalardan biri bo‘lib, hozirda butun dunyoda axborot resurslarini qayta ishlash hamda qurilma va foydalanuvchilar o‘rtasida ma’lumot almashishda muhim ro’l o‘ynaydi. Ushbu tizimlarning apparatli ta’minot tarkibi yarim o‘tkazgichli texnologiyaning shiddat bilan rivojlanishi evaziga kundan kunga yangi integral sxema hamda jihozlar bilan boyitilmoqda. Bunday sharoitda xavfsizlikni yaxshilash hamda hozirgi holati to'g'risida taqdim etilgan ma'lumotlarni optimallashtirish orqali temir yo‘l stansiya qurilmalarining samaradorligi va ishonchliligini oshirish masalalari, holatini kuzatish orqali temir yo'l transportida avtomatika va telemexanika boshqaruv tizimlarining qurilmalari tahlil qilinadi. Ushbu maqsadlarga erishish uchun quyidagilar amalga oshirilishi kerak bular; axborotni qayta ishlashning raqamli usullarini joriy etish, joriy nazoratni amalga oshirish, ma’lumotlarni qayta ishlashni takomillaashtirish, avtomatika va telemexanika qurilmalarning muhim elementlaridan biri bo‘lgan elektromagnit relelarni mikroelektron qurilmalar bilan almashtirish. Ushbu maqolada yuqorida keltirilgan kamchliklarni bartaraf etish va qo‘yilgan bir qator maqsadlarga erishish uchun Petri nazariyasi yordamida model taklif etiladi. Hamda simulyatsiya natijalari asosida, madel uchun algoritmlar ishlab chiqilgan, madel orqali aks ettirish usullari va natijalari aniqlangan.

Kalit so‘zlar: temir yo‘l transporti, elektrmaginit rele, graf nazariyasi, madel

1. Kirish

Temir yo‘l transporti mamlakatlar iqtisodiyotining eng muhim transport tarmog‘i hisoblanadi. So‘nggi yillardagi iqtisodiy o‘sish mamlakatlararo tovarlar ayirboshlash ko‘lami temir yo‘l transportiga bo‘lgan ehtiyoj va talabning yanada ortishiga olib kelmoqda. Temir yo‘llar avtomatika va telemexanika poyezdlar harakatini boshqarish tizimlari, temir yo‘ldagi jarayonlarni xavfsiz boshqarishni ta’minlash uchun zarurdir, bunda temir yo‘l avtomatika va telemexanika tizimlari transport jarayonlarini xavfsiz

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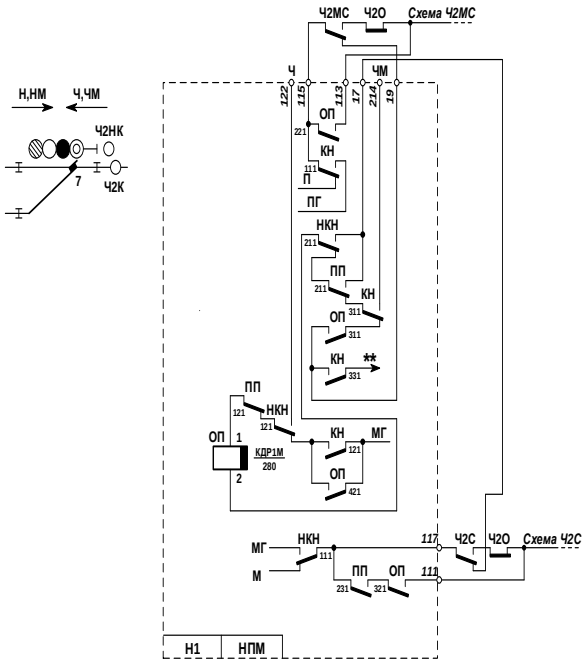
boshqarishni ta’minlaydi. Bunda boshqarish tizimining asosiy jihati havfsizligi sanaladi, ushbu tizimning maqbul jihati ham aynan shu yani tashishni tashkil etishda texnologik jarayonlarni boshqarish tizimlarining xavfsizligi hisoblanadi. Zamonaviy temir yo‘l avtomatika va telemexanikani boshqarish tizimlarining o‘ziga xos xususiyati, bu kompyuterlashtirish jarayoni va mikroelektron texnologiyalarni tadbiq etish xisoblanadi [2].

Ushbu texnologiyalarni joriy etishning asosiy sababi elektromagnit relelarni ishlatishdan voz kechish jarayoni xisoblanadi. Temir yo‘l stansiyalarida poyezdlar harakati va manevr harakatlarini boshqarish uchun blokli marshrutli releli markazlashtirish (BMRM) tizimidan foydalaniladi. Tizim maxsus tugmalar yordamida boshlash va tugatish koordinatalarini belgilashda marshrutlarni avtomatik ravishda o‘rnatadigan bloklar ko‘rinishidagi qurilmalarni o‘z ichiga oladi. Ushbu marshrutni tayinlashning o‘ziga xos xususiyati BMRM tizimida o‘rnatiladigan marshrutlarning xususiyatlari va toifalari to‘g‘risida xabardor qilish zarurati xisoblanadi [1, 3] Bunday bloklar majmuasi "yig‘ish" deb nomlanadi. BMRM tizim o‘tgan asrning 60-yillari o‘rtalarida ishlab chiqilgan bo‘lib, bunda yig‘ish bloklarida elektromagnit relelaridan foydalanilgan. Temir yo‘l avtomatika va telemexanika tizimlarining tadqiqotchilari uchun innovatsion vazifa elektromagnit relelaridan foydalanmasdan mikroelektron yig‘ish qurilmalarini ishlab chiqish xisoblanadi. Shu bilan birga, mikroelektron qurilmalar funksional jihatdan releli bloklariga to‘liq o‘xshash bo‘lishi va boshqa bloklar bilan elektromagnit relelar kabi moslikka ega bo‘lishi kerak. Ushbu maqolaning maqsadi manevr marshrutlarini o‘rnatishda umumiy takrorlanishga qarshi rele (ОП) ishlash modelini ishlab chiqish, uni tadqiq qilish va elektr zanjirlarining ishlashini boshqaruvchi mikrokontrollerning ishlash algoritmini shakillantirish xisoblanadi [5,13].

2. Tadqiqot metodologiyasi

ОП elektromagnit relesi NPM-69 blokida joylashgan bo‘lib ham manevr marshrutlarini o‘rnatishda ham, poyezd marshrutlarini o‘rnatishda ishga tushiriladi. Ushbu maqolada manevr marshrutini o‘rnatishda ushbu rele ishlashi muhokama qilinadi. Dastlabki holatda, marshrutni yig‘ish tartibli harakati bo‘lmasa, bu rele toksiz holatda bo‘ladi, uni НПМ-69 blokida qo‘zg‘atishning pinsipial sxemasi 1-rasmda keltirilgan. Umumiy takrorlanishga qarshi rele holatining grafini qurish tartibini ko‘rib chiqamiz. Shuni yodda tutish kerakki, *ОП* relesining har bir holati to‘g‘ridan-to‘g‘ri *ОП* va teskari $\overline{\text{ОП}}$ ikkita pozitsiya bilan aks ettiriladi, bunda ushbu pozitsiyalarning yig‘indisi $\text{ОП} + \overline{\text{ОП}} = 1$ formulaga muvofiq birga teng. Bu shart boshqa pozitsiyalar uchun ham bajarilishi kerak [4,6,7,8]. Grafni qurish uchun quyidagi pozitsiyalardan foydalanamiz: *КН* va - $\overline{\text{КН}}$ mos ravishda *КН* tugmachali rele holatini aks ettiruvchi, tok ostidagi rele, $\overline{\text{КН}}$ - toksiz xolatdagi rele; *НКН* va $\overline{\text{НКН}}$ - poyezd marshrutlarining boshlovchi tugmachali rele holati, manevr marshrutlarini o‘rnatishda ushbu relening toksiz xolatini tekshirish kerak; poyezd takrorlanishga qarshi rele holatini aks ettiruvchi $\overline{\text{ПП}}$ pozitsiya; 2-14 - xuddi shu nomdagi klemmada ta’minot mavjudligini aniqlaydi; *Ч2МС* va $\overline{Ч2МС}$ - mos ravishda manevr signali relesining holatini aniqlaydi.



1-rasm. *ОП* relesini yoqishning prinsipal sxemasi

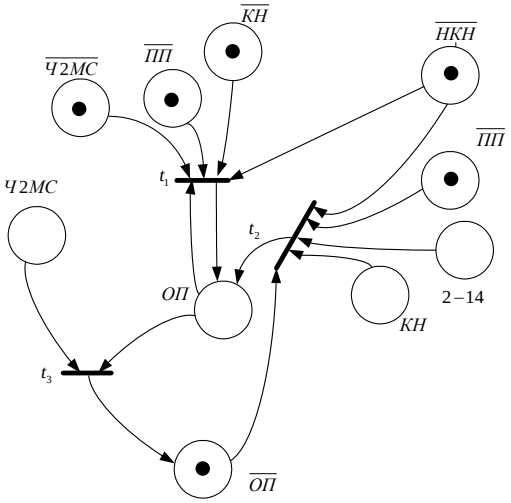
Sintez natijasida 2-rasmda ko‘rsatilgan *ОП* relesining dastlabki holatdagi grafi olingan. Ushbu grafga ko‘ra, pozitsiyalarning kirish va chiqish tenglamalari *ОП*, $\overline{\text{ОП}}$, *КН*, $\overline{\text{КН}}$,$\overline{\text{ПП}}$, *Ч2МС* va $\overline{Ч2МС}$ va shuningdek, t_1, t_2 va t_3 (1) o‘tishlar tizimi ishlab chiqilgan. Grafning holatini dastlabki holatida ko‘rib chiqamiz, bu holda *ОП* relesi toksiz holatda, shuning uchun fishka $\overline{\text{ОП}}$ pozitsiyasida, bundan tashqari fishkalar$\overline{Ч2МС}$, $\overline{\text{ПП}}$, $\overline{\text{КН}}$ va $\overline{\text{НКН}}$ relelarning toksiz xolatini aks ettiruvchi pozitsiyalarda. 2-14 chiqish klemmasida ta’minot manbai mavjud emas, bu xuddi shu pozitsiyada fishka yo‘qligi bilan aks etadi. Manevr marshrutini yig‘ishda, *КН* relesi ishga tushirilib, *ОП* relesini qo‘zg‘alishi uchun sharoit yaratilganda, graf ishlashini ko‘rib chiqamiz. Ushbu xolatning grafi 3-rasmda keltirilgan. Tenglama tizimidan (1), *ОП* relesini qo‘zg‘algan xolatini aks ettiruvchi pozitsiyaning kirish funksiyasi $I\ (\text{ОП}) = \{t_1, t_2\}$, shundan ko‘rinib turibdiki, fishkani *ОП* pozitsiyaga o‘tkazish uchun aniqlovchi shartlar t_1 va t_2 o‘tishlarni ishga tushirish xisoblanadi. Kirish o‘tish funksiyasini $I(t_1) = \{\overline{Ч2МС}, \overline{\text{ПП}}, \overline{\text{КН}}, \text{ОП}, \overline{\text{НКН}}\}$ tahlil qilishdan ko‘rinib turibdiki, formulada *ОП* relesini allaqachon qo‘zg‘algan holatini aks ettiruvchi o‘zgaruvchi mavjud, holbuki bu vaqtda *ОП* relesining aynan ishga tushish jarayoni ko‘rib chiqilmoqda. Natijada, t_1 o‘tish bo‘yicha fishkani o‘tkazish imkoni yo‘q.

Kirish formulasi $I(t_2) = \{\overline{\text{ПП}}, \overline{\text{НКН}}, 2-14, \text{КН}, \overline{\text{ОП}}\}$ bo‘yicha o‘tish shartlarini ko‘rib chiqamiz, bunda barcha o‘zgaruvchilar *ОП* relesini ishlashiga va fishkani pozitsiyasiga o‘tkazilishiga mos keladi, chunki *ППП*, *НКН* relelar toksiz xolatda va bu holatni aks ettiruvchi $\overline{\text{ПП}}$ va $\overline{\text{НКН}}$ pozitsiyalar fishkalarga ega, *КН* tugmachali relesining pozitsiyasi va manevr marshruti uchun *КН* 2-14 klemmalarining pozitsiyalari ham o‘z pozitsiyalarida va 2-14 ham fishkalarga ega [9,10,11,12].

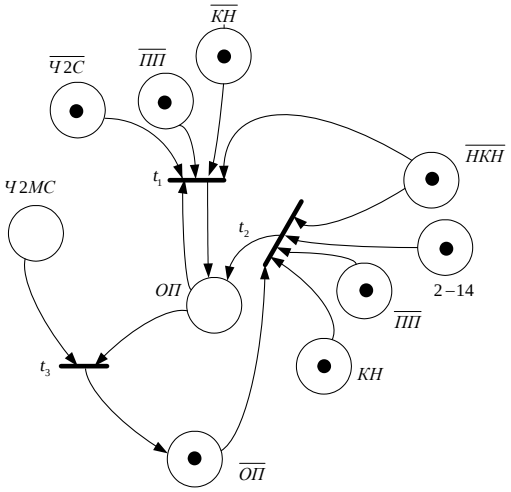
Manevr marshrutini o‘rnatishda *ОП* relesi ishga tushirilgandan so‘ng, u o‘z-o‘zini bloklashi kerak, bu holatning grafi 4-rasmda keltirilgan. O‘z-o‘zini bloklash protsedurasi *ОП* pozitsiyada fishka mavjudligini nazarda tutadi, tugmachali rele holatini o‘zgartirgandan so‘ng, fishka

pozitsiyadan yo‘qoladi. *ОП* pozitsiyada fishkaning mavjudligi, o‘zgaruvchi mavjud bo‘lgan kirish funksiyasiga $I(t_1) = \{\overline{Ч2МС}, \overline{ППП}, \overline{КН}, ОП, \overline{НКН}\}$ muvofiq t_1 o‘tishni ishga tushirish orqali ta’minlanadi, bunda $\overline{КН}$ o‘zgaruvchi mavjud. Ushbu o‘tishning chiqish funksiyasi $O(t_2) = \{ОП\}$ fishkani *ОП* pozitsiyaga ko‘chirishga yordam beradi va shu bilan manevr marshrutini o‘rnatishda *ОП* relesini o‘z-o‘zini bloklashda graf holati aks ettiriladi.

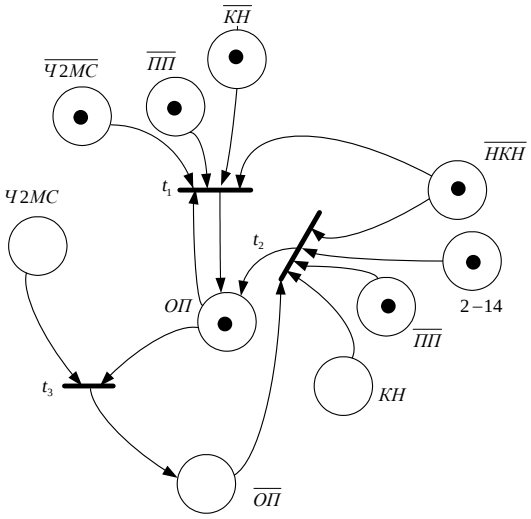
$I\ (\overline{ОП}) = \{t_3\}; O\ (\overline{ОП}) = \{t_2\};$
$I\ (ОП) = \{t_1, t_2\}; O(ОП) = \{t_1, t_3\};$
$O\ (\overline{ППП}) = \{t_1, t_2\};$
$O\ (КН) = \{t_2\};$
$O\ (\overline{КН}) = \{t_1\}$
$O(Ч2МС) = \{t_3\};$ (1)
$O(\overline{Ч2МС}) = \{t_1\};$
$O(\overline{НКН}) = \{t_2\};$
$O(2-14) = \{t_2\};$
$I(t_1) = \{\overline{Ч2МС}, \overline{ППП}, \overline{КН}, ОП, \overline{НКН}\}; O(t_1) = \{ОП\};$
$I(t_2) = \{\overline{ППП}, \overline{НКН}, 2-14, КН, \overline{ОП}\}; O(t_2) = \{ОП\};$
$I(t_3) = \{ОП, Ч2МС\}; O(t_3) = \{\overline{ОП}\}.$



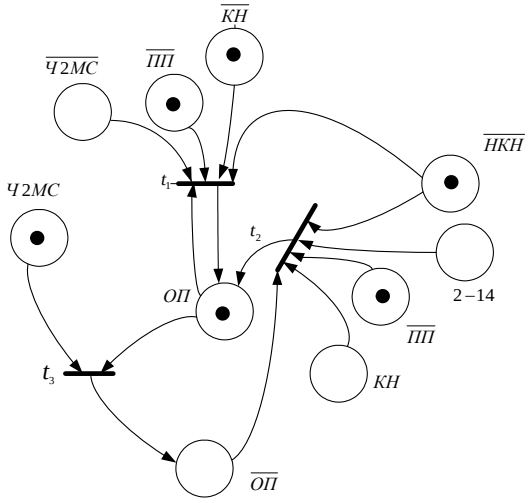
2-rasm. Manevr marshruti uchun *ОП* relesining boshlang‘ich holati grafigi



3-rasm. Fishkani pozitsiyaga o‘tkazishga tayyor bo‘lgan holat uchun grafik



4-rasm. Manevr marshrutining *ОП* relesini o‘z-o‘z bloklash holati uchun grafik



5-rasm. Manevr marshrutining *ОП* relesini o‘chirishdagi holat uchun grafik

ОП relesining toksiz xolatida modelning ishlashini ko‘rib chiqamiz, uning graf holati 5-rasmda keltirilgan. Modelda bu jarayon fishkalarni *ОП* pozitsiyadan $\overline{ОП}$ pozitsiyaga o‘tkazish bilan birga keladi. Uzatish operatsiyasi kirish funksiyasi $I\ (\overline{ОП}) = \{t_3\}$ yordamida, ya’ni, uning kirish funksiyasini $I(t_3) = \{ОП, Ч2МС\}$ o‘tishini ishga tushirish bilan amalga oshiriladi. 5-rasmdagi grafik holatidan ko‘rish mumkin. Bunda t_3 o‘tishni ishga tushirish mumkin, chunki *ОП* va *Ч2МС* pozitsiyalarda fishkalar mavjud, ya’ni, rele tok ostidaligiga mos keladigan. t_3 o‘tishni ishga tushirish natijasida $\overline{ОП}$ pozitsiyada fishka paydo bo‘ladi, *ОП* va *Ч2МС* pozitsiyalardan esa fishka yo‘qolib qoladi va graf 2-rasmga mos ravishda *ОП* relening dastlabki xolati ko‘rinishini oladi.

3. Xulosa

Yuqoridagi keltirilgan taklif etilayotgan usul temir yo‘l transportida elektromagnit relelardan foydalanishni kamaytirish ularning o‘rniga zamonaviy tehnologiyalardan foydalangan holda mikroelektron qurilmalardan foydalanish iqtisodiy samaradorlikni oshishiga, ishlabchiqarish harajatlarini kamayishiga, qurilmalarga hizmat ko’rsatish

sfatini yahshilanishiga nosozliklarni erta aniqlash va bashorat qilish imkonini oshishiga olib keladi.

Foydalangan adabiyotlar / References

[1] Сороко, В. И. Аппаратура железнодорожной автоматики и телемеханики : справ. : в 2 кн., Кн. 2. – 3-е изд. / В.И. Сороко, Е.Н. Розенберг– М. : НПФ «Планета», 2000. – 1008 с.

[2] Azizov A. R., Ubaydullayev S. Q., Ametova E. K. Model of push-button relay circuits for shunting routes //AIP Conference Proceedings. – AIP Publishing, 2023. – Т. 2612. – №. 1.

[3] Model of Circuits of Anti-repeat Relays of Train Routes Yusupov, Z., Azizov, A., Ametova, E., Ubaydullaev, S. Lecture Notes in Networks and Systems, 2024, 718 LNNS, страницы 161–168.

[4] Каменев А. Ю. Особенности применения экспериментальных методов доказательства безопасности систем микропроцессорной централизации стрелок и сигналов / А. Ю. Каменев // Информационно-управляющие системы на железнодорожном транспорте. 2011. – № 4. – С. 104–111. – ISSN 1681-4886.

[5] Азизов А.Р., Аметова Э.К. Метод математического моделирования организационно-технологической системы диагностирования микропроцессорных блоков наборной группы железнодорожной автоматики и телемеханики //Известия Транссиба. 2023. № 1 (53). С. 36-45.

[6] Бестемьянов П.Ф. Методы повышения безопасности микропроцессорных систем интервального регулирования движения поездов. Докторская диссертация, Москва, 2001, 324с.

[7] Aripov N., Sadikov A., Ubaydullayev S. Intelligent signal detectors with random moment of appearance in rail lines monitoring systems //E3S Web of Conferences. – EDP Sciences, 2021. – Т. 264. – С. 05039.

[8] A.Azizov. Microelectronic device for control of rail line integrity in Uzbekistan. E3S Web of Conferences, 2024, 583, 07007.

[9] Каменев А. Ю. Особенности применения экспериментальных методов доказательства безопасности систем микропроцессорной централизации стрелок и сигналов / А. Ю. Каменев // Информационно-управляющие системы на железнодорожном транспорте. –2011. – № 4. – С. 104–111. – ISSN 1681-4886.

[10] Azizov A. et al. Development, research of a model and an algorithm for organizing data transfer in a monitoring device //E3S Web of Conferences. – EDP Sciences, 2023. – Т. 371. – С. 03069.

[11] E. Ametova. Framework development for software functionality in Uzbekistan's block route centralization system. E3S Web of Conferences, 2024, 592, 07017.

[12] Гаюбов Т. Н., Садиков А. Н., Убайдуллаев С. К. Исследование нелинейных систем при приеме случайных сигналов. //Universum: технические науки. – 2023. – №. 1-2 (106). – С. 45-47.–

[13] Азизов А.Р., Убайдуллаев С.Қ., Модель цепей кнопочных реле поездных маршрутов в блоке управления системы блочной маршрутной релейной централизации. Муҳаммад ал-Хоразмий авлодлари. Муҳаммад ал-Хоразмий номидаги Тошкент ахборот технологиялари университети 2022, №2(20) 125-129 б.

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