USE OF INTELLIGENT DIAGNOSTIC SYSTEMS FOR OPTIMAL CONTROL OF THE MANIPULATOR

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Abstract: *Remote control optimize instrument performance, calibration, and measurement error minimization. The measurement system includes all devices and methods that implement the measurement process. In the mathematical model, the role of the structure of the system, the methods of operation and the error model is important.*

Key words: *Remote control, Manipulators, Robot technologies, Automation, Sensors, Control system, Real-time mode, IoT (Internet of Things), Software, Remote communications, Digital control systems.*

Bu avtomatik ravishda qurilma yoki tizimning holatini tahlil qilish, xatoliklarni aniqlash va tizimning ishlash samaradorligini kuzatish imkonini beruvchi texnologik tizimdir. Aqlli diagnostika tizimlari odatda sun'iy intellekt (AI), mashina o‘rganish (ML), sensorlar, va real vaqt ma'lumotlarini qayta ishlash imkoniyatlariga asoslangan bo‘ladi. Aqlli diagnostika tizimlari odatda sun'iy intellekt (AI), mashina o‘rganish (ML), sensorlar, va real vaqt ma'lumotlarini qayta ishlash imkoniyatlariga asoslangan bo‘ladi. Bu tizimlar yordamida texnik nosozliklar va muammolarni oldindan aniqlash, avariyalarning oldini olish va tizimni optimallashtirish mumkin. Aqlli diagnostika tizimining asosiy funktsiyalari nosozliklarni aniqlash Aqlli diagnostika tizimlari tizimni optimallashtirish imkonini beradi. Misol uchun, energiya sarfini kamaytirish yoki texnologik jarayonlarni tezlashtirish uchun ishlash parametrlarini sozlash mumkin. Xatolikni

kamaytirish formulasi asosan tizimlarning samaradorligini oshirish, xatoliklarni oldini olish va optimallashtirishga qaratilgan matematik yondashuvlarga asoslanadi. Xatolikni kamaytirish jarayonida ba'zi asosiy parametrlar va yondashuvlarni hisobga olish kerak. Quyidagi formulalar va yondashuvlar bu jarayonda yordam berishi mumkin: Xatolikni kamaytirishning umumiy yondashuvi quyidagicha ifodalanadi:

$$E = \frac{1}{N}\sum_{i=1}^{N}(y_i - \Delta y_i)^2$$

E- xatolik (error), N- namunalar soni (odatda vaqt yoki hodisa soni), y_i– haqiqiy (kutilgan) qiymat, Δy_i –model tomonidan bashorat qilingan qiymat.

Ushbu formula o'rtacha kvadrat xatolik (Mean Squared Error - MSE) deb ataladi va modelning aniqligini baholashda keng qo'llaniladi. Agar bu xatolikni minimallashtirishni maqsad qilgan bo'lsak, MSE ni kamaytirishga harakat qilamiz. Xatolikni kamaytirish uchun optimallashtirish (Gradient descent): Gradient Descent algoritmi yordamida xatolikni kamaytirish uchun quyidagi yondashuvlar ishlatiladi:

$$\theta_{new} = \theta_{old} - \eta * \nabla_\theta J(\theta)$$

Bu yerda: $\theta -$ model parametrlari (masalan, og'irliklar yoki koeffitsientlar), η –o'zgartirishning o'lchov (learning rate), $\nabla_\theta J(\theta) -$ xatolik funktsiyasining gradienti.

Bu formulada gradient yordamida modelning parametrlarini yangilash orqali xatolikni minimallashtirishga harakat qilinadi. $\theta -$ parametrini to'g'ri tanlash xatolikni samarali kamaytirishda muhim ahamiyatga ega. Xatolikni kamaytirish va

signalni kuchaytirish (Signal-to-Noise Ratio - SNR): Xatoliklarni kamaytirish uchun signal va shovqin nisbatini (SNR) optimallashtirish mumkin. SNR o'lchovini hisoblash formulasi quyidagicha bo'ladi:

$$SNR = \frac{\mu_s}{\sigma_n}$$

Bu yerda: μ_s – signalning o'rtacha qiymati,

σ_n – shovqin (noaniqlik) qiymatining standart og'ishi.

SNR ning yuqori bo'lishi tizimning sifatli ishlashini va xatoliklarning kamayishini bildiradi. Ushbu ko'rsatkichlarni optimallashtirish orqali modelning ishonchliligini va xatolikni kamaytirish imkoniyatini oshirish mumkin. Xatolikni kamaytirish jarayoni tizimning samaradorligini oshirish va noto'g'ri natijalar yuzaga kelishining oldini olishga qaratilgan. Yuqorida keltirilgan formulalar va yondashuvlar xatolikni aniqlash va minimallashtirish uchun samarali vositalar hisoblanadi.

Xatoliklar va xavflarni kamaytirish aqlli tizimlar yordamida potensial xavfli holatlar, masalan, qisqa tutashuvlar, haddan tashqari qizib ketish yoki mexanik xatoliklarni oldindan aniqlash va oldini olish mumkin. Uzluksiz monitoring va yangilanishlar aqlli diagnostika tizimlari avtomatik ravishda tizimni kuzatib boradi va yangilashlar, o'zgartirishlar yoki dasturiy ta'minotdagi o'zgartirishlar haqida ogohlantiradi. Aqlli diagnostika tizimining foydalanish sohalari sanoat ishlab chiqarish Avtomatik tizimlar va mashinalarni diagnostika qilish orqali ishlab chiqarish jarayonlarini samarali boshqarish va nosozliklarni erta aniqlash. Robototexnika va manipulyatorlar Robotlar va manipulyatorlarning ish faoliyatini monitoring qilish, ularning texnik holatini tahlil qilish va nosozliklarni oldindan aniqlash. Energiya sektori elektr stansiyalari, gaz va suv ta'minoti tizimlaridagi asbob-uskunalarni tahlil qilish va avariyalarni oldini olish. Aqlli diagnostika tizimi tizimlarning samaradorligini oshirish, nosozliklarni erta aniqlash va ishning

uzluksizligini ta'minlash uchun muhim vosita bo'lib, texnologiyalar rivojlanishiga qarab tobora kengroq qo'llanilmoqda.

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