



PREDICTING NEW WIND SPEEDS USING THE MARKOV CHAIN METHOD AND MEASURED WIND SPEEDS

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ABSTRACT

In this paper, the method of forecasting wind speed using Markov chain, in other words, transition matrices, is considered. While studying the topic, it should be noted that this method is useful for generating (predicting) data very close to the actual values. Wind speed data from wind stations often have gaps in the measurements for various reasons. The results show that the Markov chain is a very effective method for filling short-term gaps in the data series.

MARKOV ZANJIRI USULI VA O'LCHANGAN SHAMOL TEZLIKLARIDAN FOYDALANGAN HOLDA YANGI SHAMOL TEZLIKLARINI BASHORAT QILISH

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ABSTRACT

Ushbu maqolada Markov zanjiri, boshqacha qilib aytganda, o'tish matritsalarini yordamida shamol tezligini bashorat qilish usuli muhokama qilinadi. Mavzuni o'rganayotganda shuni ta'kidlash kerakki, bu usul haqiqiy qiymatlarga juda yaqin bo'lgan ma'lumotlarni yaratish (prognozlash) uchun foydalidir. Shamol fermalaridan olingan shamol tezligi ma'lumotlari ko'pincha turli sabablarga ko'ra o'lchov bo'shliqlariga ega. Natijalar shuni ko'rsatadiki, Markov zanjiri ma'lumotlar seriyasidagi qisqa muddatli bo'shliqlarni to'ldirishning juda samarali usuli hisoblanadi.



So'nggi yillarda butun dunyo bo'ylab ko'plab elektr tarmoqlari kompaniyalari tomonidan qayta tiklanadigan energiya manbalaridan (QTEM) foydalanish sezilarli darajada oshdi. Shamol, quyosh va biomassa an'anaviy yoqilg'i o'rnini bosadigan asosiy uchta qayta tiklanadigan energiya manbalaridir. Ushbu turdagi energiyaning afzalliklaridan biri atmosferaga CO₂ ishlab chiqarishni kamaytirishdir [1-2]. Aytish mumkinki, global isish ham an'anaviy manbalar CO₂ ishlab chiqarishga boy bo'lganligi sababli energiya ishlab chiqarishning muqobil manbalarini izlash sabablaridan biridir [1-3].

Shamol energetikasi qayta tiklanadigan manbalar orasida energiya ishlab chiqarish uchun tasdiqlangan manba bo'lib, global, ijtimoiy va iqtisodiy muhitga ijobiy hissa qo'shadi. Shamol energetikasi bozori so'nggi yillarda rivojlanmoqda va kelgusi davrda iqtisodiyotning muhim qismi hisoblangan ko'plab shamol turbina qurilmalari qurilishi kerak. Shamol energetikasi sohasining bunday jadal rivojlanishi ham ilmiy-tadqiqot ishlari tufaylidir. Sohadagi muammolar orasida shamol tezligini tushunish va olingan bilimlarni sanoatda qo'llash kiradi. Shamol stansiyalarida shamol harakatini bilish bugungi energiya tizimlari uchun, ayniqsa dasturlash va ishlatish vositalarida juda muhim, shamol energiyasi kelajakdagi energiya manbalarining muhim qismiga aylanadi [2-3].

Bunga, shamol mos keladigan joylarda shamol turbinalari o'rnatish orqali erishish mumkin. Biroq, shamol tezligining noaniqligi, bu haqiqatga mos keladigan energiya tizimlarini rejalashtirish va ishlatish uchun turli xil qiyinchiliklarni keltirib chiqaradi. Shu sababli, shamol tezligini bashorat qilish va tahlil qilish uy uchun shamol turbinasi (mikro avlod) mos keladimi yoki yo'qmi yoki energiyaga bo'lgan ehtiyojni to'ldirishi mumkin bo'lgan shamol stansiyalariga investitsiya qilish kerakmi yoki yo'qmi degan qarorga olib kelishi mumkin [4].

Ushbu maqolada shamol tezligini bashorat qilish uchun Markov zanjiri usuli (MZU) ishlatilgan. Ushbu usul shamol tezligining stokastik tabiati tufayli, shamol tezligi holatlari o'rtasida paydo bo'lish va o'tish ehtimolini hisobga olgan holda tanlangan [5-6]. Bunga qo'shimcha ravishda, Markov zanjiri usuli paydo bo'lish ehtimollik bilan bir qatorda chiqish quvvati holatlari o'rtasidagi o'tish ehtimoligini ham ko'rib chiqadi va shuning uchun ehtimollik taqsimoti funktsiyasi (ETF) bilan solishtirganda shamol tezligining intervalgacha harakatini batafsilroq qamrab oladi. Markov jarayoni shamol resurslarini tahlil qilish uchun ishlatilgan bo'lib, shamol tezligi holatlari o'rtasidagi vaqtinchalik munosabatlarni o'tish ehtimollik matritsasi yordamida ko'rib chiqish afzalligini ta'kidlab, shamol tezligini modellashtirish uchun ETF -dan foydalanilganda yuqorida aytib o'tilgan afzallik e'tibordan chetda qoladigan masala ekanligini [7] adabiyotdan ko'rishimiz mumkin.

MZU stokastik yondashuv bo'lib, bu tizim holatining ehtimoligini oldingi holatidan baholay oladi. Shamol tezligini bashorat qilishda MZU dan foydalanganda, birinchi navbatda, tarixiy (o'lchangan) ravishda yig'ilgan shamol tezligiga ega bo'lish kerak. Ushbu tadqiqotda bashorat qilish uchun bir yillik soatlik yig'ilgan tarixiy ma'lumotlardan foydalangan. Ma'lumotlar O'zbekistonning Jizzax viloyatidan to'plangan.

MZU yordamida tarixiy o'lchangan ma'lumotlardan yangi shamol tezligini bashorat qilish uchun asosiy qadamlar quyidagilardan iborat [4,8]:

1. Shamol tezligining tarixiy (o'lchangan) ma'lumotlarini to'plang va bu shamol tezligini, shamol tezligining amplitudasiga qarab diskret holatlar (states) soniga ajrating.



2. Holat tasniflangandan so'ng, t vaqtdan $(t+1)$ vaqtga l holatdan boshqa m holatga o'tish ehtimollik P_{lm} ni quyidagicha ifodalash mumkin:

$$P_{lm} = \frac{n_{lm}}{\sum n_{lm}}; \quad l, m = 1, 2, \dots, s; \quad l \neq m \quad (1)$$

bu yerda, n_{lm} l holatdan m holatiga o'tish soni

$s \times s$ matritsaning o'tish ehtimollik matritsasi (O'EM) o'tish ehtimollik P_{lm} bilan quyidagicha tuzilgan:

$$P = (p_{lm}) = \begin{pmatrix} p_{11} & p_{12} & \dots & p_{1s} \\ p_{21} & p_{22} & \dots & p_{2s} \\ \dots & \dots & \dots & \dots \\ p_{s1} & p_{s2} & \dots & p_{ss} \end{pmatrix} \quad (2)$$

3. TPM yig'ilgan (cumulative) ehtimollik matritsasi (YEM) ga aylantiriladi.

Agar k -holatda l -qatorida o'tish ehtimoli P_{lk} mavjud bo'lsa, u holda yig'ma ehtimollik P_{lk} bo'ladi va quyidagicha ifodalanadi:

$$P_{lk} = \sum_{m=1}^k P_{lm}; \quad l, k = 1, 2, \dots, s \quad (3)$$

4. 0 dan 1 gacha bo'lgan tasodifiy N sonlarni yarating

5. Tasodifiy boshlang'ich holatni tanlang va l sifatida belgilang

6. Agar tasodifiy yaratilgan N qiymati YEM ning l -qator elementidan ($N \leq p_{il}$) kichik yoki teng bo'lsa, u holda 1 keyingi holat bo'ladi. Agar N YEM ning l -qatoridagi 1-elementdan kattaroq bo'lsa va bir xil satr uchun dastlabki ikkita element yig'indisidan kichik yoki unga teng bo'lsa, keyingi holat 2 bo'ladi.

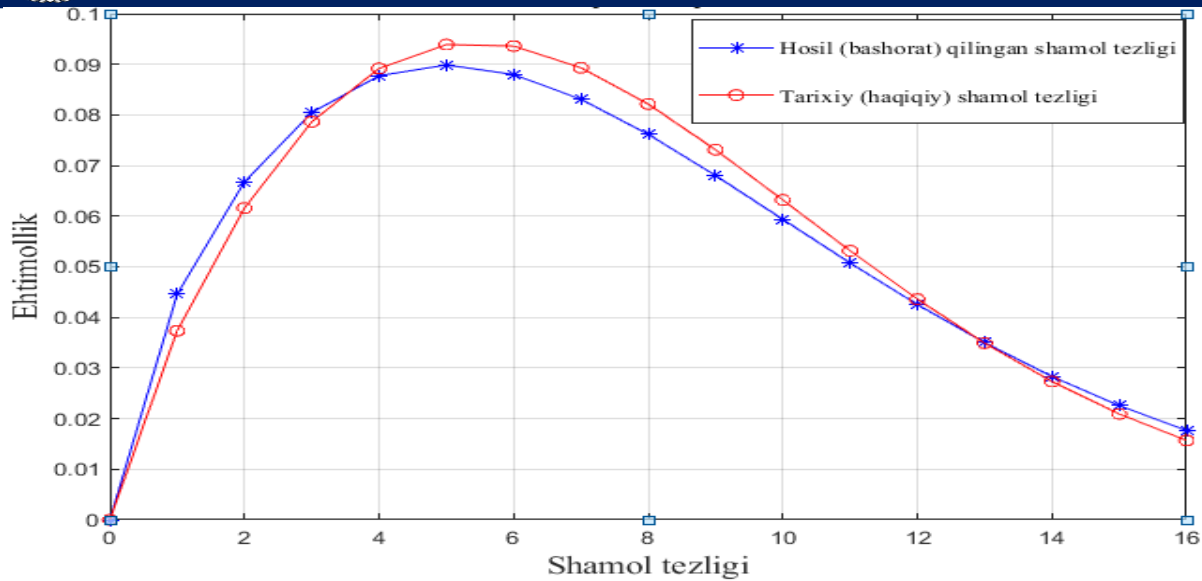
7. YEM ning l holatidan yangi m holatiga o'tish shamol tezligiga quyidagicha o'tkazilishi mumkin:

$$v_s = v_{m-1} + N_l(v_m - v_{m-1}) \quad (4)$$

bu yerda, v_m va v_{m-1} shamol tezligining yuqori va pastki chegaralari, N_l tasodifiy yaratilgan sonidir.

Joriy holatni dastlabki holat sifatida hisobga oling va (6) va (7) qadamlarni har bir tasodifiy raqam uchun takrorlash orqali istalgan uzunlikdagi shamol tezligini yaratish (bashorat qilish) mumkin.

1-rasmda hosil qilingan shamol tezligi ehtimollik va tarixiy o'lchangan shamol tezligi ehtimolligining solishtirilgani ko'rsatilgan.



Rasm-1. Hosil (bashorat) qilingan va tarixiy (haqiqiy) shamol tezligi ehtimolligi (taqsimoti)

Xulosa qilib shuni ta'kidlash kerakki, ushbu uslub haqiqiy qiymatlarga juda yaqin bo'lgan shamol tezliklari ma'lumotlarini yaratish (bashorat qilish) uchun foydalidir. Ko'pincha shamol stansiyalaridan olingan shamol tezligi ma'lumotlari turli sabablarga ko'ra o'lchovlarda bo'shliqlarga ega. Markov zanjiri usuli ma'lumotlar seriyasidagi qisqa muddatli bo'shliqlarni to'ldirish uchun juda samarali usul ekanligini yuqoridagi solishtirishdan ko'rishimiz mumkin.

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