ENERGIYA SAMARADORLIGINI OSHIRISH UCHUN ULANGAN VA AVTOMATLASHTIRILGAN TRANSPORT VOSITALARINING PROGNOZLI IQLIM NAZORATI MODELI

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Annatotsiya. Ushbu maqolada biz gibrid va elektr transport vositalariga konditsionerli holda boshqarishda ko'proq e'tibor qaratmoqdamiz.

Annattosion. In this article, we're focusing more on driving hybrid and electric vehicles with air conditioning.

Аннотация. В этой статье мы больше сосредоточимся на вождении гибридных и электрических автомобилей с кондиционером.

Kalit so'zlar: Cool-Sim, avtomobil tezligi va ob-havo sharoitlarini oldindan ko'rish -HVAC

Keywords: Cool-Sim, vehicle speed and weather forecast -HVAC

Ключевые слова: Cool-Sim, скорость автомобиля и прогноз погоды -HVAC

Ulangan va avtomatlashtirilgan transport vositalarida (CAV) V2V, V2I va ilg'or sensorlar orqali mavjud bo'lgan ma'lumotlar vaziyatdan xabardorlikni oshiradi, transport sharoitlarini oldindan ko'rishni ta'minlaydi va aqlli qaror qabul qilishni osonlashtiradi. Yoqilg'i tejamkorligining yaxshilanishi va/yoki energiya iste'molining kamayishi alohida qiziqish uyg'otadi, bunga CAVlarda erishish mumkin. Yo'lovchi bo'linmasini isitish, ventilyatsiya qilish va konditsionerlash (HVAC) va elektr motor uchun ishlatiladigan issiqlik yuklari va batareya paketini sovutish, engil yuk mashinalari uchun eng muhim yordamchi yuklarni ifodalaydi [1]. Hisob-kitoblarga ko'ra, Amerika Qo'shma Shtatlarida engil avtomobillar uchun konditsioner (A/C) tizimini quvvatlantirish uchun yiliga taxminan 7 milliard gallon yoqilg'i sarflanadi [1]. Argonne National Labs-da o'tkazilgan tadqiqot, UrbanDynamometer Haydash jadvali (UDDS) bo'yicha sinovdan o'tkazilgan konditsioner tufayli transport vositasini boshqarish masofasini 53,7% va Ford Focus EV uchun isitish tufayli avtomobilni boshqarish masofasini 59,3% qisqartirishini ko'rsatdi [2]. Xuddi shunday, Nissan Leaf

[2] va National Renewable Energy Laboratoriyasi tomonidan olib borilgan so'nggi ishda haydash masofasining sezilarli darajada qisqargani haqida xabar berilgan.

Ushbu maqolada biz gibrid va elektr transport vositalariga e'tibor qaratmoqdamiz, bu erda konditsioner tizimining kompressori elektr dvigatel tomonidan boshqariladi va to'g'ridan-to'g'ri bortdagi yuqori voltli batareyalar to'plamidan quvvat oladi. Biz bug'ni siqish aylanishiga asoslangan bunday konditsioner tizimini keng qamrovli modellashtirish juda katta ahamiyatga ega ekanligini ta'kidlaymiz [9]. Bizning keyingi ishlanmalarimiz [10] dan yuqori aniqlikdagi simulyatsiya modelidan va bashorat qilish uchun foydalaniladigan va bizning yuqori aniqlikdagi modelimizga nisbatan tasdiqlangan soddalashtirilgan boshqaruvga yo'naltirilgan modeldan foydalanadi. bashorat qilish va energiya sarfini minimallashtirish uchun yo'naltirilgan model. Shuningdek, biz amaliy tadqiqotlar orqali kelajakdagi avtomobil tezligi profilidagi CAV-larni oldindan ko'rishdan sovitish tizimining energiya sarfini yanada kamaytirish uchun foydalanish mumkinligini ko'rsatamiz. Qolgan maqolalar quyidagicha tashkil etilgan. Yuqori sifatli simulyatsiya modeli va soddalashtirilgan bashorat modelini ishlab chiqish tafsilotlari II bo'limda keltirilgan. Bizning iqlimni bashorat qilish modelini loyihalash III bo'limda tasvirlangan. IV bo'lim simulyatsiya natijalarini taqdim etadi va energiya samaradorligini oshirishni namoyish etadi

CoolSim yuqori aniqlikdagi modeli va tezlik sezgirligi tahlili. Milliy qayta tiklanadigan energiya laboratoriyasida (NREL) mavjud bo'lgan ochiq manbali modellashtirish muhiti bo'lgan CoolSim asosida yengil avtomobil A/Csystem yuqori aniqlikdagi simulyatsiya modeli yaratilgan, qarang [11]]. 1-rasmda CoolSim-dagi konditsioner tizimining Simulink® modelining sxemalari ko'rsatilgan. Ushbu modelda to'rtta asosiy kichik komponent mavjud: (i) harorat va bosim kabi tezlik profillari va atrof-muhit sharoitlarini ta'minlaydigan chegaraviy shartlar bloki; (ii) evaporatator, kondensator, kondensator ventilyatori, evaporatator klapan va ulash quvurlarining batafsil modellaridan iborat sovutish sxemasi bloki; (iii) konditsioner tizimidagi asosiy energiya iste'molchisi sifatida sovutish pallasidan alohida modellashtirilgan kompressor bloki va (iv) kabinaning issiqlik dinamikasini modellashtiruvchi kabina bo'shliq bloki (2-rasmda batafsil ma'lumotlar ko'rsatilgan. sxemalar va qog'ozda ko'rib chiqilgan asosiy haroratlar). Har bir kichik komponentning modellashtirish tafsilotlari uchun [10] ga qarang. Ushbu model A/Csystemning sikl bo'yicha xatti-harakatlarini simulyatsiya qilish qobiliyatiga ega va [10] da eksperimental ma'lumotlarga nisbatan tasdiqlangan. Elektr va kamar bilan boshqariladigan kompressor konfiguratsiyalari mavjud bo'lsa-da, elektr bilan boshqariladigani ushbu maqolada ko'rib chiqiladi.

Ushbu modelda qo'llaniladigan nominal kontroller ikkita proportsional-plyus-integral (PI) boshqaruv tsiklidan iborat bo'lib, shamolga qarshi va konditsionerni yoqish-o'chirish mantig'iga ega. PI pastadirlaridan biri bug'latgich devori haroratining o'rnatilgan nuqtasini kuzatish uchun kompressor tezligini sozlaydi. Boshqa PI halqasi

kabinadagi havo harorati sozlangan nuqtasini kuzatish uchun puflagich tezligini tartibga soladi. Idishdagi havoning aylanma tezligi kabina havosi harorati va atrof-muhit harorati o'rtasidagi farqga mutanosib ravishda bog'liq va fizik mumkin bo'lgan chegaralarga muvofiq to'yingan bo'ladi. Simulyatsiya 600 soniya vaqt oralig'ida turli xil doimiy avtomobil tezligida (Vveh =0, 5, 10, 15, 20 va 25 m/s) va bir xil maqsadli kabina havo harorati o'rnatilgan nuqtada amalga oshiriladi.
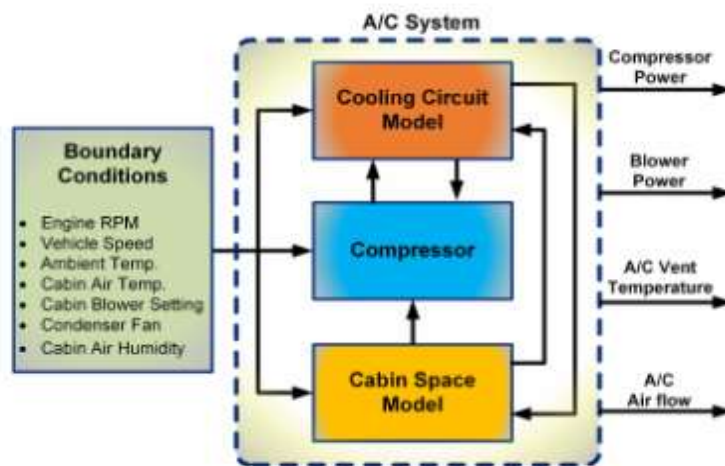

Fig. 1.   Schematics of the CoolSim Simulink® Model.

CoolSim modelining simulyatsiya natijalari shuni ko'rsatadiki, konditsioner tizimining samaradorligi avtomobil tezligi oshgani sayin ortib boradi. Bu kuzatuv asosiy fizikaga mos keladi, chunki avtomobil tezligi oshgani sayin kondanser orqali samarali ramair tezligi ortadi, shuning uchun kondanser issiqlikni tezroq tarqatadi, bu esa konditsioner tizimining umumiy samaradorligini oshiradi. Shunga o'xshash xulosaga [[. 12]. I-jadvalning ikkinchi qatorida keltirilgan qiymatlarga ko'ra, havo sovutish tizimining samaradorligi avtomobil tezligi 0 m/dan oshishi bilan taxminan 30% ga oshadi. s (to'xtash holati) 25 m/s gacha. Avtotransport tezligiga nisbatan sezgirlik sayohat masofasi bilan normallashtirilgan energiya sarfini hisobga olgan holda yanada aniqroq bo'ladi.
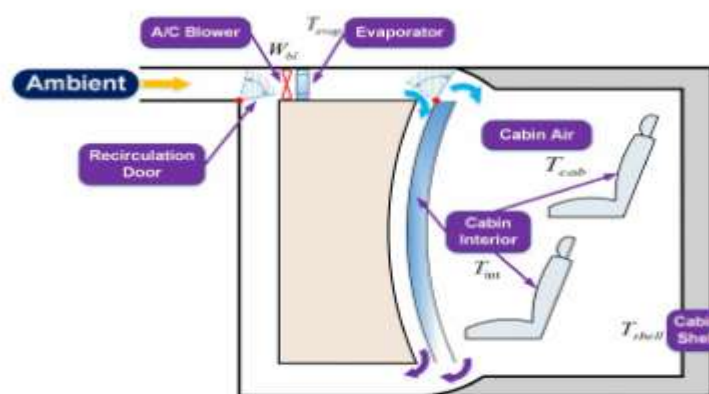

Fig. 2.   Schematics of the cabin model.

Yuqori tezlikda harakatlanadigan avtomobil bir xil masofani bosib o'tish uchun kamroq vaqt sarflaydi, bu esa konditsionerning ishlash vaqtini va shu bilan bog'liq energiya sarfini kamaytiradi. Ushbu tezlik sezgirligidan konditsionerni bashorat qiluvchi kontroller dizaynida foydalanish mumkin. I-jadvaldagi raqamlarni ko'rib chiqish uchun shuni ta'kidlaymizki, konditsioner energiya iste'moli shaharda haydashda tortish kuchining uchdan bir qismini tashkil qiladi.
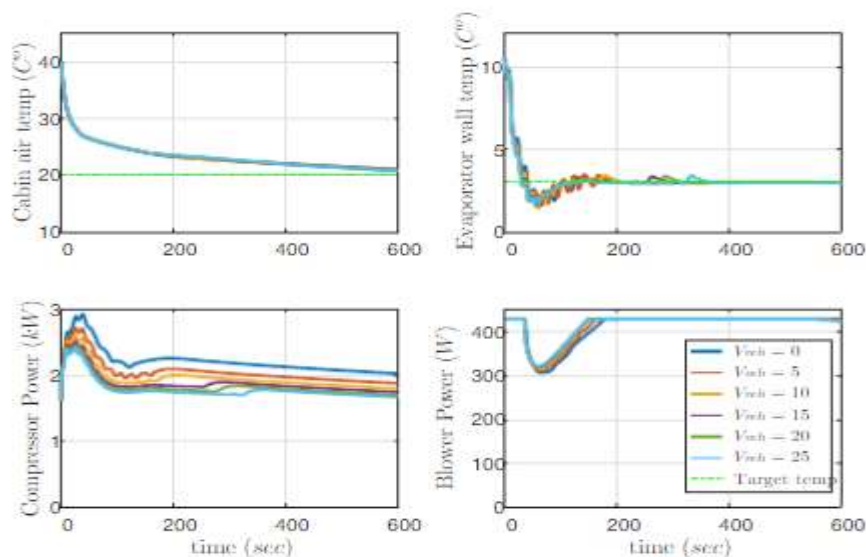

Fig. 3. Vehicle speed sensitivity demonstrated on CoolSim model.

Gibrid elektr yo'lovchi avtomobillarida energiyani tejash va (potentsial) diapazonni kengaytirish uchun iqlim nazoratining prognozli asosi modeli ushbu maqolada taqdim etilgan. Bog'langan va avtomatlashtirilgan avtomobillarda paydo bo'ladigan imkoniyatlardan foydalanish, avtomobil tezligi va ob-havo sharoitlarini oldindan ko'rish HVAC boshqaruviga birlashtirilishi mumkin. Ushbu ishda iqlimni bashorat qilish algoritmini sinash uchun virtual sinov maydoni sifatida yuqori aniqlikdagi konditsioner tizimining modeli (CoolSim) qabul qilindi. Haqiqiy vaqt rejimida optimallashtirishni amalga oshirish uchun A/C tizimining boshqaruvga yo'naltirilgan bashorat modeli ishlab chiqildi va CoolSim modeli ma'lumotlari bilan tasdiqlandi. Keyinchalik, konditsioner tizimining energiya sarfini minimallashtirish uchun chiziqsiz MPC (NMPC) muammosi shakllantirildi va hal qilindi. Taklif etilgan NMPC kontrollerining ishlashi CoolSim modeli bilan yopiq tsiklda tasdiqlandi. Kelajakdagi avtomobil tezligi haqidagi ma'lumotni konditsionerni boshqarish muammosiga kiritishning afzalliklarini ko'rsatish uchun, vaqt bo'yicha o'zgaruvchan idishni harorati cheklovi bilan tezlik bilan bog'liq bo'lgan sinov stsenariysi an'anaviy doimiy idishni haroratini sozlash stsenariysi bilan taqqoslandi. Natijalar shuni ko'rsatdiki, idishni haroratini avtomobil tezligi profili bilan muvofiqlashtirish konditsioner tizimining energiya samaradorligini 9% gacha oshirishga olib kelishi mumkin. Kelajakdagi ishlar avtomobil tezligi sezgirligini, qo'shimcha qulaylik cheklovlarini ko'rib chiqishni, ob-havo/issiqlik kiritish prognozlarini o'z ichiga olgan

holda bashorat qilish modelini yaxshilashga, shuningdek, avtomobil tezligi va konditsioner tizimining ishlashini birgalikda optimallashtirishga qaratilgan.

Xulosa - Ushbu maqolada akkumulyatorli yoki gibrid elektr uzatmalari bo'lgan kelajakda ulangan va avtomatlashtirilgan transport vositalarida (CAV) avtomobil konditsionerlari (A/C) tizimiga modelli bashoratli boshqaruv qo'llanilishi ko'rib chiqiladi. A/C tizimi uchun boshqaruvga yo'naltirilgan bashorat modeli taklif qilingan, aniqlangan va yuqori aniqlikdagi simulyatsiya modeliga (CoolSim) qarshi tasdiqlangan. Ishlab chiqilgan bashorat modeliga asoslanib, energiya sarfini minimallashtirish uchun chiziqli bo'lmagan model bashoratli boshqaruv (NMPC) muammosi ishlab chiqilgan va hal qilinadi. Simulyatsiya natijalari tavsiya etilgan NMPC yechimining kerakli xususiyatlarini ko'rsatadi, masalan, sovitish tizimining jismoniy cheklovlarini qo'llash va idishni haroratini belgilangan diapazonda ushlab turish. Bundan tashqari, avtomobil tezligini oldindan ko'rish va idishni harorati cheklovlarini muvofiqlashtirilgan sozlash orqali energiya samaradorligini 9% gacha oshirish mumkinligi ko'rsatilgan.

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