ТЕЗИ СТЕНДОВИХ ДОПОВІДЕЙ ТА ВИСТУПІВ УЧАСНИКІВ КОНФЕРЕНЦІЇ

HIGHLIGHTS OF REPORTS AND PRESENTATIONS OF PARTICIPANTS TO THE CONFERENCE

advantages. Concurrently, significant research gaps have been identified in the areas of revenue management and transport policy.

For the successful future integration of AI, it is imperative to address several fundamental challenges. Firstly, data-related problems, including ensuring data quality, accessibility, and standardization, as well as developing methods to work with limited or imbalanced datasets (e.g., for rare events like accidents). Secondly, the development of hybrid approaches that merge AI with traditional optimization methods to solve multifaceted problems. Thirdly, the growing importance of intelligent cybersecurity amidst the increasing digitalization and automation of railway systems. Addressing these challenges will pave the way for creating safer, more efficient, and sustainable railway transportation for the future.

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Tetyana Petrenko, PhD, Associate Professor
Oleksii Poluektov, master's student
Ukrainian State University of Railway Transport, Kharkiv

SMART HOME SYSTEM DESIGN

Modern smart home systems are rapidly developing due to the integration of Internet of Things (IoT) and Artificial Intelligence (AI) technologies. Creating an adaptive environment using the Artificial Internet of Things (AIoT) to improve the comfort, safety, and energy efficiency of living space is the main task of smart home systems [1-2]. The current problem is the selection or creation of such an architecture of a smart home system that provides a certain autonomy of the system, but allows the user to intervene in the system as needed. Analysis of typical scenarios of everyday life of smart home users with subsequent control of lighting, temperature and humidity, air quality, water supply, energy supply, and security makes it possible to build a coordinated functioning of a significant number of smart things in a smart home.

The purpose of the work is to analyze possible solutions for using existing platforms to create a smart home system, justify the choice of a particular platform and design a smart home system that prioritizes flexibility and innovative solutions and allows the use of machine learning algorithms to build smart home control scenarios. The functioning of the designed system should correspond to the strategy of intuitive interaction with system users. In other words, the smart home system should be a good assistant, but not create unnecessary problems for system users.

This paper examines the ecosystems of three typical smart home architectures as ESPHome, Apple Home, and Google Home and identifies the advantages of the ESPHome architecture for creating a flexible and scalable smart home system.

The features of a smart home system built on the basis of ESPHome are:

1. The ESPHome ecosystem can be a standalone system, or be part of a larger Home Assistant ecosystem, allowing for the connection of devices and services not only compatible with ESPHome.
2. The ESPHome ecosystem is an open source system.
3. The system developer on ESPHome (administrator) can control both the hardware and software of the system. Edge computing based on machine learning can be implemented.
4. The control part of the system can be distributed (no hub required), or can use the hub of the Home Assistant ecosystem. ESPHome devices can function as autonomous IoT devices.
5. Dependence on external Internet connections is minimized. Local API and MQTT are used for communication, including with Home Assistant.
6. To form the microcontroller software in ESPHome, a Python-based firmware generator is used, which processes a YAML configuration file to create its own customized C++ firmware. The firmware is installed on ESP-based microcontrollers, after which the devices operate independently.
7. Access of the ESPHome-based smart home system to cloud environments is possible, and

data confidentiality is provided through priorities.

8. Building a smart home system based on ESPHome requires certain knowledge from the developer, but opens up prospects for creating an individualized and tamper-proof system.

Comparing the ESPHome, Apple Home, and Google Home ecosystems, we can highlight the advantages of ESPHome as a decentralized, open-source platform for creating firmware for Do It Yourself (DIY) smart devices, which prioritizes local control. Apple and Google, on the other hand, offer commercial cloud ecosystems built around their own hubs and centralized services.

To determine the functionality of the smart home subsystems, the work uses modeling methods based on UML diagrams to describe static and dynamic aspects, and Fuzzy Cognitive Maps (FCMs) to analyze the internal dynamics of the system. This approach allowed us to create a holistic set of models as an architectural basis for further implementation. The conceptual model, which is created in the form of a UML use case diagram, defines the actors, system boundaries, and key system functions. The physical model, represented by a deployment diagram, describes the hardware architecture. For the analysis of dynamics, a cognitive model is proposed in the form of an FCM, the modeling of which allows us to analyze the relationships between key components and determine priority areas for system improvement. The behavior of the system for key scenarios is illustrated by dynamic models created using UML Sequence and Activity diagrams.

The conducted research shows the importance of using modeling methods such as UML and FCM to create a balanced and logically consistent architecture of a smart home based on ESPHome. The key aspect is to identify a compromise between maximizing the comfort of the residents of a smart home and minimizing energy consumption. An effective solution to this problem is possible only with the help of intelligent algorithms capable of making decisions regarding the adaptability of the smart home system. The conclusions drawn on the basis of system modeling allowed the work to formulate key areas of designing a smart home based on ESPHome. In the future, the integration of the designed system into Node-RED should contribute to the creation of an intelligent and user-oriented smart home system.

References

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Tetyana Petrenko, PhD, Associate Professor
Anton Zadorozhnyi, PhD student; Vladyslav Snehirov, master's student;
Kateryna Aleksieieva, bachelor's student
Ukrainian State University of Railway Transport, Kharkiv

DESIGN OF A SMART TRAFFIC LIGHT CONTROL SYSTEM BASED ON FUZZY COGNITIVE MAPS

In modern cities, there is an increase in the intensity of traffic flows and congestion, an increase in the level of accidents and a decrease in road safety. Traditional traffic light systems that operate on fixed cycles do not consider the dynamics of the traffic situation and are therefore often ineffective [1]. This highlights the need to create intelligent control systems that can adapt the duration of traffic light phases depending on real-time conditions, the presence of pedestrians, the appearance of emergency service cars and the presence of emergencies.

A smart traffic light has access to network communication with other traffic lights, an external dispatch service, and cloud environments, unlike a traffic light that operates thanks to a local automation system. The presence of certain sensors and actuators (mandatory components of a smart traffic light) does not make a regular traffic light truly smart, but, of course, it expands the possibilities of making more informed decisions if the traffic light has certain computing capabilities. A smart traffic light must be provided with autonomous power supply for a certain period and be able to receive additional power to replenish the electricity supply. Thus, the necessary conditions for defining a smart traffic light are the presence of computing capabilities, sensors and actuators, autonomous power supply, and Internet connection. The presence of a traffic light connection with the Internet ensures the transition of the traffic light to the category of intelligent traffic lights, because in this case the traffic light not only gets the opportunity for a more advanced representation of the state of the environment, but also gets access to cloud environments with powerful computing capabilities. If the computational capabilities of the traffic light are sufficient to use machine or deep learning algorithms, then the use of edge computing is possible. Certain requirements for the quality of communication with the Internet are essential for an intelligent traffic light.