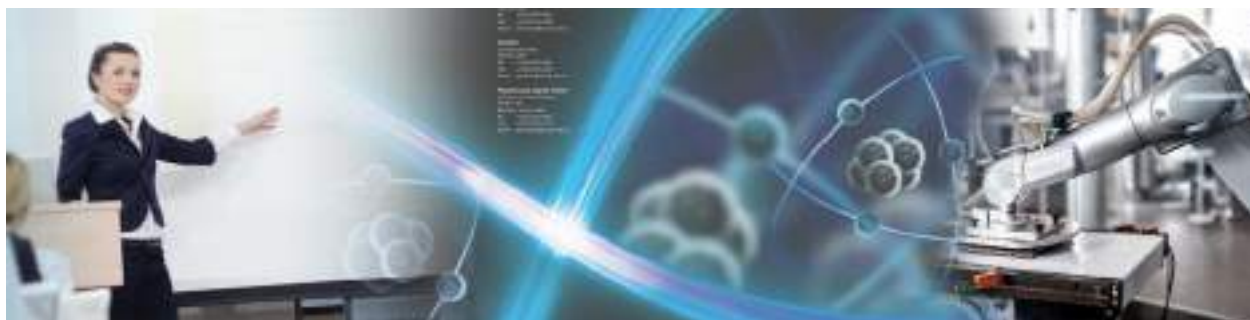


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ВИРОБНИЦТВО
&
МЕХАТРОННІ СИСТЕМИ 2025**



**IX International Conference
MANUFACTURING
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Features of automatic working time control systems

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Annotation: The research is devoted to the development and implementation of automatic working time control systems, which are an important tool for improving personnel management efficiency and optimizing business processes. The paper discusses the features of creating a web application based on the Vuetify framework, using the SQLite database and the server part on Node.js. The main focus is on automating work time accounting processes, including employee check-in/check-out registration, performance analysis, and report generation. The study analyzes the advantages of using a lightweight SQLite database for small and medium-sized organizations, as well as the integration of modern front-end technologies to create a user-friendly interface. The work includes the practical implementation of the system, demonstrating its functionality, and provides an analysis of the challenges associated with ensuring data security, scalability, and integration with other systems. Visual elements such as diagrams and graphs contribute to a better understanding of the structure and functionality of the developed application. The study emphasizes the importance of automated systems for modern organizations, offering recommendations for their implementation and improvement.

Key words: time and attendance systems, Vuetify, SQLite, Node.js, automation, web application, human resources management, productivity.

I. INTRODUCTION

In modern conditions, automation and robotization processes play a key role in improving the efficiency of enterprises, allowing to minimize the human factor, reduce time costs, and ensure the accuracy of processing large data sets [1-8]. The use of digital technologies and automatic information collection systems creates the basis for transparency in business processes and contributes to the formation of intelligent personnel management systems [9-12].

In modern conditions, working time management is an important aspect for increasing the productivity of organizations. Automatic working time control systems allow you to optimize accounting, reducing manual labor and increasing data accuracy. The growing demand for such systems is due to the need for transparency of work processes, especially in the context of remote work and business digitalization.

The development of web applications for such systems opens up new opportunities for companies of various scales. The use of the Vuetify framework ensures the creation of an adaptive and convenient interface, SQLite offers simple and effective data storage, and Node.js allows you to implement fast server logic. Together, these technologies create a flexible solution that is easily deployed and adapted to user needs.

The purpose of the study is to analyze the features of creating automatic working time control systems, develop a

prototype of a web application based on selected technologies and evaluate its effectiveness in real conditions. The relevance of the work is explained by the growing need for automation of personnel management in the modern business environment.

II. ARCHITECTURE OF THE AUTOMATIC WORKING TIME CONTROL SYSTEM

Automatic working time control systems perform a number of key functions aimed at improving the efficiency of personnel management. They allow you to record working hours (track employee arrival and departure times), analyze productivity (assess working hours and time efficiency), generate reports (create analytical reports for management and accounting), and ensure transparency (providing employees and employers with access to working time data).

The automatic working time control system (AWTCS) includes the following main components:

- front end – a user interface that allows employees to record their working hours and managers to view the data;
- backend – the core of the system that processes requests from the frontend, implements business logic, and provides communication with the database;
- database – responsible for storing information about working hours, attendance, changes, and other parameters.

The generalized architecture of the AWTS is shown in Fig. 1.

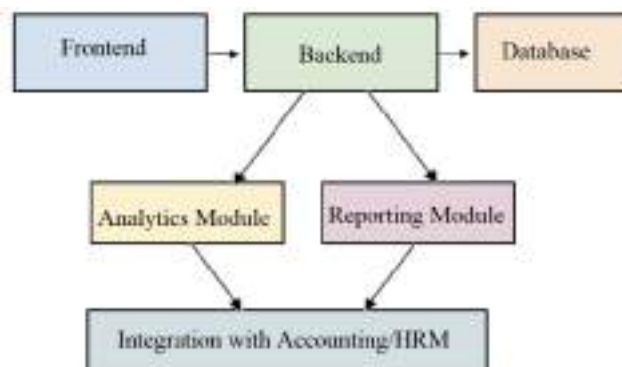


Fig. 1. Generalized architecture of the AWTS

Analytics module – analyzes collected data, allows you to identify patterns, monitor performance, and forecast indicators.

Reporting module – generates reports for management, accounting, and HR departments (e.g., information about hours worked, tardiness, vacations).

Accounting/HRM integration module – provides automatic data exchange with external systems, simplifying payroll calculation and personnel management.

The successful implementation of all these modules depends on the right choice of technologies and development tools. Table 1 shows the main advantages of using the selected technologies in AWTS.

Table 1. ADVANTAGES AND LIMITATIONS OF AUTOMATIC WORKING TIME CONTROL SYSTEMS TECHNOLOGIES

Technology	Advantages of use	Restrictions on use
Vue.js + Vuetify	<ul style="list-style-type: none"> - adaptive design; - rapid interface development; - support for Material Design components; - reactivity and two-way data binding; - easy integration with the backend. 	<ul style="list-style-type: none"> - limited SEO optimization for Single Page Applications (SPA); - dependence on JavaScript in the browser; - need for additional configuration for large projects; - bundle size can be significant.
Node.js + Express.js	<ul style="list-style-type: none"> - high performance for I/O operations; - asynchronous request processing; - extensive ecosystem of npm modules; - single programming language (JavaScript); - rapid development and prototyping. 	<ul style="list-style-type: none"> - not optimal for CPU-intensive tasks; - single-threadedness can be a limitation; - rapid changes in the ecosystem; - need for additional caching for high loads.
PostgreSQL	<ul style="list-style-type: none"> - high performance and scalability; - support for complex queries and indexes; - ACID compliance and reliability; - advanced role and security system; - support for JSON and other data types. 	<ul style="list-style-type: none"> - more complex configuration and administration; - higher server resource requirements; - need for specialized Database Administrator knowledge; - more complex backup.
JWT (JSON Web Tokens)	<ul style="list-style-type: none"> - stateless authentication; - easy scalability; - self-sufficient tokens with metadata; - support for various encryption algorithms. 	<ul style="list-style-type: none"> - it is difficult to revoke tokens before their expiration date. - the token size may be large. - secret keys must be stored securely. - security risks if implemented incorrectly.

The presented technology stack ensures the creation of a scalable and reliable AWTC system capable of serving from several dozen to thousands of users. The combination of selected technologies allows you to implement all key system functions: from recording working hours to generating analytical reports.

For successful implementation of the system, a phased approach is recommended: first, develop basic functionality

using the simplest components of the stack, and then gradually add more complex analytics modules and integration with external systems.

III. FEATURES OF DEVELOPING A WEB APPLICATION FOR WORKING TIME CONTROL

The development of a web application for monitoring working hours involves creating a system that combines convenience, functionality, and reliability [13-17].

The development process covers several key stages, from planning the application structure to testing the finished product.

First, the user interface is designed using the Vuetify framework. This framework, built on Vue.js, offers a set of ready-made components that comply with Material Design standards, ensuring an aesthetic and consistent look for the application on different devices. For example, to display employee working hours, components such as cards and tables are used, which allow dynamic display of information with the ability to sort and filter.

A distinctive feature of Vuetify components is their reactivity, meaning they automatically update when data changes, making the interface lively and user-friendly. In addition, Vuetify supports themes that can be customized to match your corporate style, and has built-in support for localization, making it easy to adapt your application for different languages.

One important aspect is the integration of Vue Router with Vuetify to manage navigation in the application. Vue Router allows you to create a single-page application with multiple routes, for example, for authentication pages, viewing working hours, generating reports, and settings. A special feature of this integration is the use of Vuetify components such as v-navigation-drawer for the sidebar or v-app-bar for the top navigation bar, which are synchronized with the routes. This ensures smooth transitions between pages without reloading, improving the user experience.

When configuring routes, it is important to consider security, for example, using guard functions that check user authorization before accessing certain sections, adding a layer of security to the frontend.

The next step is to develop the server side using Node.js. This technology allows you to create a fast and scalable backend using the Express.js library to organize API routes. The server processes requests from the client, executes business logic, such as calculating total working time based on records, and interacts with the database.

A distinctive feature of Node.js is its asynchronous execution model, which is ideal for I/O operations such as database queries, allowing multiple requests to be processed simultaneously without blocking.

SQLite, a lightweight database that does not require a separate server process and stores all information in a single file, is used for data storage. The peculiarities of creating tables in SQLite lie in the use of simple SQL queries to define the structure. For example, a table for employees may include fields for ID, name, position, and contact details, created using the CREATE TABLE command with specified data types, such as INTEGER for IDs and TEXT for names.

For the working time records table, fields are added for date, entry and exit times, as well as a foreign key to reference the employee table, ensuring relational integrity.

An important feature is the use of indexes to speed up searches, for example, on the date field to quickly extract data for a period.

In addition, SQLite supports transactions, which allows you to perform multiple operations atomically, preventing data loss in case of errors.

Frontend and backend integration is achieved through asynchronous HTTP requests using the Axios library on the client side. Axios simplifies sending requests, handling responses and errors, allowing you to configure headers, for example, for authentication using tokens.

A special feature of Axios is the ability to use interceptors that intercept requests or responses to add authorization tokens or handle errors such as session expiration. For example, to get a list of employees, the client sends a GET request to the /api/employees endpoint, and the server returns the data in JSON format, which is then displayed in Vuetify components.

Similarly, to save a new record about working hours, a POST request with a body containing the necessary data is used, after which the server inserts it into the database using an INSERT SQL query and returns a confirmation.

PUT requests are used to update data, and DELETE requests are used to delete it, providing full CRUD functionality. A special feature of this interaction is asynchronous processing: Axios returns promises that integrate with the reactive properties of Vue.js, allowing the interface to be updated automatically after receiving a response. In addition, for optimization, you can use request caching or debounce functions to avoid excessive load on the server during rapid changes in the interface.

Component testing is also taken into account during development. Vuetify offers tools for unit testing using Jest or Vitest, where you can check component rendering and their interaction with data. For the backend, Node.js allows you to integrate tests with Mocha or Jest, checking API endpoints and interaction with the database. Overall, this structure ensures the creation of a reliable web application that effectively controls working time.

IV. CHALLENGES AND LIMITATIONS OF DEVELOPING WORKING TIME CONTROL SYSTEMS

The development of automatic working time tracking systems is associated with certain challenges. One of the main ones is ensuring data security. Since the system stores information about employees, it is necessary to protect it from unauthorized access. The work uses password encryption methods and authentication based on JWT tokens, but SQLite does not support built-in encryption, which requires additional security measures.

Another challenge is scaling the system. SQLite is effective for small organizations, but as the number of users or data volume increases, it may be necessary to switch to a more powerful database, such as PostgreSQL. This requires additional effort to migrate data and adapt the system.

Integration with other systems, such as accounting software or HRM platforms, is also challenging. The variety

of data formats and protocols requires careful API planning and compatibility testing.

Creating a user-friendly interface is another important aspect. Despite the advantages of Vuetify, developing an intuitive design that meets the needs of different user groups requires a deep understanding of UX principles and testing. Figure 2 shows a diagram of the main development challenges.

V. CONCLUSIONS

The development of an automatic working time control system using Vuetify, SQLite, and Node.js allows you to create effective and affordable solutions for personnel management. We plan to develop a web application that will automate working time accounting, analyze productivity, and generate reports, which will increase transparency and reduce the time spent on administrative processes.

Vuetify will provide a modern and responsive interface, Node.js will ensure fast request processing, and SQLite has proven to be the optimal choice for small and medium-sized businesses due to its ease of deployment and lack of specialized administration requirements.

An analysis of the architecture shows that the modular structure of the system, with a clear division into front-end, back-end, and database, creates a foundation for further scaling and expansion of functionality. The integration of analytics, reporting, and external system modules allows for the creation of a comprehensive solution for automating HR processes.

The study revealed the key advantages of the proposed approach:

1. Speed of implementation – the use of ready-made components and frameworks reduces development time by 40-60 %.
2. Cost-effectiveness – no licensing costs for core technologies reduces the total cost of ownership.
3. Flexibility of adaptation – modular architecture allows you to easily customize the system to the specific needs of your organization.
4. Ease of maintenance – the use of popular technologies ensures the availability of specialists for further support.

At the same time, the study revealed the limitations of the existing solution. The use of SQLite limits horizontal scaling capabilities for large enterprises with thousands of employees. The lack of built-in encryption in SQLite creates additional challenges for ensuring the security of personal data. Dependence on JavaScript on the client side can create problems in organizations with strict browser security policies.

Thus, the study shows that such systems are an important tool for organizations seeking to optimize human resource management. However, to ensure security, scalability, and integration with other platforms, it is necessary to consider the limitations of the selected technologies.

Further development of automatic working time tracking systems may include the introduction of artificial intelligence for analyzing productivity data or a transition to cloud solutions to improve scalability.

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