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AUTOMATED MODULAR APPLICATION DEVELOPMENT

This article presents the concepts of Automated Modular Application Development (AMAD), which utilizes automated mechanisms to facilitate and accelerate the software development process. Building on the Sens4U concept and leveraging the tinyDSM middleware, AMAD automates the selection of appropriate sensors and system configurations, minimizing manual user intervention.

ZAUTOMATYZOWANE MODUŁOWE TWORZENIE APLIKACJI

W artykule przedstawiono koncepcje zautomatyzowanego modułowego rozwoju aplikacji (AMAD), wykorzystującego zautomatyzowane mechanizmy, aby ułatwić i przyspieszyć proces tworzenia oprogramowania. Opierając się na koncepcji Sens4U i wykorzystując middleware TinyDSM, AMAD automatyzuje wybór odpowiednich sensorów i konfiguracji systemu, minimalizując ręczną ingerencję użytkownika.

1. INTRODUCTION

In the face of rapid technological advancement and increasing demand for software, the process of software development is becoming more complex and time-consuming. Traditional methods, largely relying on manual programming effort, often lead to errors, delays, and budget overruns. These challenges prompt the search for new solutions to streamline and optimize the software development process.

One such tool is based on the concept of Automated Modular Application Development (AMAD), which utilizes automated mechanisms to facilitate and expedite this process. AMAD is built upon the idea of Sens4U [1], which supports modular application development, where individual components can be easily integrated as they use defined interfaces and are parameterized to simplify the module choice. The original Sens4U concept, combined with the automation of sensor selection and system configuration, will significantly reduce manual programmer intervention, resulting in time savings, reduced error risk, and cost optimization. The Sens4U idea is based on the modularity of available libraries, enabling faster application development even for individuals who are not experts in the field. Integration with AMAD enhances these benefits, making application development even more accessible and efficient. Sens4U plays a crucial role in AMAD because its approach to building modular applications is perfectly aligned with the AMAD concept. With Sens4U, the automation of library selection, such as sensor drivers, becomes an integral part of the AMAD process, ensuring even greater efficiency and effectiveness in modular application development.

A key feature of AMAD is its ability to automatically select the most optimal set of sensors and adapters for a given application. For example, if an application requires measurements of temperature, pressure, and humidity within certain power constraints, the tool will intelligently suggest the best-matched sensors from the library. Each sensor in the library is described with metadata, including energy consumption, interface specifications, and other relevant characteristics. These comprehensive metadata enable precise selection and configuration, ensuring smooth integration and optimal performance.

Through the tinyDSM middleware [2], AMAD will simplify the selection of appropriate sensors and system configurations, minimizing user manual intervention. Consequently, the application development process will become more efficient and precise, leading to the creation of high-quality software in less time. TinyDSM is dedicated to wireless sensor networks (WSN), facilitating data storage and processing for sensor cooperation and data management in such networks. TinyDSM is flexible and scalable, making it suitable for various WSN applications, such as environmental monitoring, smart building systems, and the Industrial Internet of Things (IIoT).

2. PROPOSED TOOL

The conceptual tool called Automated Modular Application Development (AMAD) is a solution designed to support the design and implementation of modular applications by automating the process of selecting sensors and adapters that align with specified requirements as shown in Fig 1. This tool enables users to quickly and effectively match the appropriate components to their application, thereby accelerating the entire process of developing modular applications.

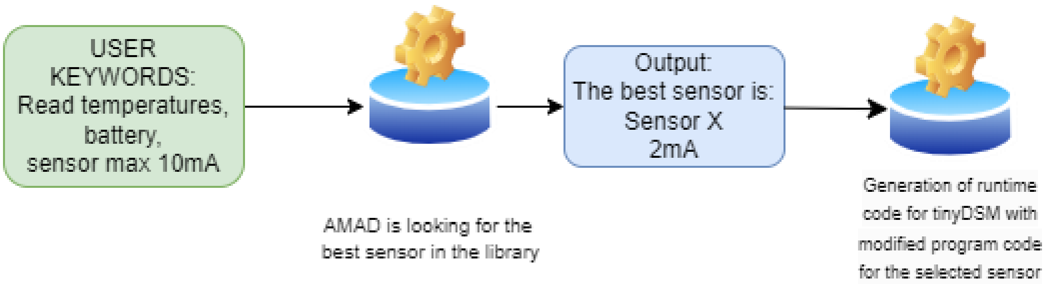

Fig. 1 Flow of the proposed tool
Rys. 1 Przepływ działania proponowanego narzędzia

AMAD allows users to precisely define the requirements of their application, such as measurement parameters, power constraints, and communication interfaces. Subsequently, based on the provided requirements, the tool conducts an analysis and proposes to the user an optimal set of sensors and adapters that meet the specified criteria. The proposal considers both measurement parameters and power constraints. The tool provides an intuitive user interface, allowing users to browse through the proposed sets of sensors and adapters and select their preferred options. Upon selection, the tool generates the corresponding source code, which can be used to run the modular application in the TinyDSM environment. The source code is modified to accommodate the chosen sensors and adapters while meeting the specified requirements.

3. EXTENSION OF MODULE INTERFACES

Automated Modular Application Development (AMAD) is based on the Sens4U approach, which utilizes scalable module interfaces and adapters to ensure an unprecedented level of automation in managing modular applications. Developing these interfaces by defining the data used plays a crucial role in AMAD, facilitating monitoring, control, and module adaptation, which are essential for the effective operation of the system.

The scalable module interfaces and adapters in AMAD enable precise control over data flow and interactions between modules, providing several benefits:

- Better monitoring: Detailed insight into module data and status allows comprehensive real-time system analysis, anomaly identification, and parameter optimization. With extended interfaces, defining data types, metadata, and access control mechanisms makes data interpretation easier and ensures its security.

- Precise control: AMAD enables defining data processing rules and access control mechanisms, ensuring control over data flow and system security. Scalable interfaces allow precise determination of who has access to data and what operations they can perform on it.
- Adaptation to changing conditions: AMAD allows dynamic adjustment of module parameters and configurations in response to changing environmental conditions or user needs. Scalable interfaces facilitate monitoring module status and defining adaptive rules, providing system flexibility and scalability.
- Quick issue resolution: AMAD provides diagnostic mechanisms for quickly identifying and resolving issues. Scalable interfaces facilitate tracking module status, error monitoring, and report generation, reducing the time needed to restore system stability.

TinyDSM serves as middleware dedicated to wireless sensor networks (WSN). It can be used as a platform for implementing an AMAD prototype, leveraging its flexibility, scalability, and diagnostic features. The scalable interfaces of TinyDSM facilitate data monitoring and control, ensuring stability and security in the AMAD system.

4. INTEGRATION WITH ONTOLOGY

Implementing ontology integration within Automated Modular Application Development (AMAD) will bring numerous benefits that can significantly enhance the efficiency and effectiveness of the modular application development process. Utilizing ontology enables a more precise definition of module attributes, relationships, and constraints, contributing to better requirements analysis and system design. With ontological knowledge representation, developers can define module functionalities and their relationships more accurately, facilitating system architecture planning and further development.

Furthermore, ontology integration supports the process of module verification and validation by enabling automatic checks for compliance with established criteria and standards. Thus, ontology serves as a supportive tool for ensuring software quality within AMAD, leading to reduced error risks and ensuring system stability. Another benefit of ontology utilization is the automation of module analysis and evaluation processes. Leveraging ontological knowledge representation allows the development of advanced analysis and inference algorithms that support decision-making regarding module selection, configuration, and integration. Consequently, the modular application development process becomes more automated and efficient, saving time and resources.

Integration with ontology also facilitates the scalability and evolution of the system. With a consistent ontological knowledge representation, new modules can be easily integrated and adapted to changing user requirements and needs. Thus, ontology serves as a foundation for the development and improvement of modular applications within the concept of AMAD.

Applying ontology within AMAD will bring a range of benefits that will significantly impact the efficiency and effectiveness of the modular application development process. Through better definition of module attributes, relationships, and constraints, automation of analysis and evaluation processes, and facilitation of scalability and system development, ontology integration represents a significant step towards optimization, automation, and advancement in the development of conceptual software like AMAD.

5. SEMANTIC APPROACH TO DATA

The semantic approach to data within Automated Modular Application Development (AMAD) will contribute to effective information management in the modular system. In AMAD, the semantic approach [4] to data will involve describing variables in middleware in a way that considers their significance and context, especially in the context of communication between nodes and gateways. In the semantic approach to defining variables in middleware, each variable is described not only based on its value but also based on its significance and relationships with other variables. For example, a variable representing temperature can be described not only as a number but also as an environmental parameter that influences the operation of other modules in the system.

There are several benefits associated with the semantic approach to data in AMAD. Firstly, it enables better understanding of data significance, contributing to more effective data management. By describing data in the context of their significance and relationships, the system will be able to detect patterns, predict behaviours, and make intelligent decisions based on information gathered by various modules. The semantic approach to data will enable intelligent data management by utilizing semantics for automatic understanding, interpretation, and processing of information. For example, the system can detect anomalies, identify trends, and propose optimal actions based on semantic data analysis, leading to better system performance and effectiveness. The semantic approach to data will support interoperability among different modules in the AMAD system, allowing communication and exchange of information in a way that is understandable to all participants. With semantic data description, modules will be able to effectively collaborate, share information, and achieve common goals.

6. SUMMARY AND DEVELOPMENT PERSPECTIVES

Given the rapid technological advancement and growing demand for software, the concept of the AMAD tool emerges to automate and enhance the process of creating modular applications. By leveraging the Sens4U approach and the tinyDSM middleware, AMAD will enable the automatic selection of an optimal set of sensors and adapters, resulting in time savings, reduced error risk, and cost optimization. In the future, the AMAD concept could be expanded to include artificial intelligence integration, which could further optimize and streamline the process of creating modular applications. Adding artificial intelligence could enable more advanced algorithms for module selection, configuration, and integration, enhancing the adaptability, scalability, and performance of the entire system.

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