1 Summary

1.1 Motivation:

The paper is motivated by the critical challenges faced in implementing efficient smart agriculture systems, particularly in handling large volumes of data. The purpose is to explore innovative solutions that can enhance the overall performance and reliability of smart agriculture platforms. The aim is to investigate the integration of low-code development patterns, with a specific focus on the Edge ETL pattern, to overcome key obstacles in data collection, processing, and system scalability.

1.2 Contribution:

The primary contribution of the paper lies in introducing a set of adaptable low-code functional patterns implemented as Node-RED flows, with a special emphasis on the Edge ETL pattern. These patterns are designed to address specific challenges in smart agriculture, such as data loss, service availability, scalability, and onboarding efficiency. The innovative application of these patterns, particularly in the context of the smart agriculture digital twin use case, leads to significant improvements in data collection, system reliability, and overall efficiency.

1.3 Methodology :

The methodology leverages low-code patterns from the PHYSICS project, applied in a smart agriculture digital twin use case. Key technologies include Node-RED, an open-source visual programming tool, and the FaaS cloud paradigm, implemented using the OpenWhisk open-source FaaS platform. The deployment involves edge devices such as Raspberry Pi, serving as execution environments for simulation logic encapsulated into functions. The process includes orchestrating the logic through an event-driven execution model, utilizing the Split Join pattern for parallelized execution, and incorporating the FaaS time window monitoring pattern for high availability. Additionally, the Edge ETL pattern is employed for reliable data collection at the edge. This comprehensive approach ensures adaptability, scalability, and efficient data management in smart agriculture.

1.4 Conclusion :

To sum up the section, the paper introduces low-code patterns, particularly the Edge ETL pattern, to tackle smart agriculture challenges. It showcases adaptability in real-world scenarios, employing Node-RED and edge devices. The conclusion highlights the broad applicability of the proposed solution, offering a practical approach for reshaping smart agriculture and other sectors requiring robust data collection from IoT devices.

2 Limitations

2.1 First Limitation:

One notable limitation of the presented work is the focus on the Edge ETL pattern, with the evaluation of other low-code patterns still in progress. While the Edge ETL pattern demonstrates success in mitigating data loss and improving system efficiency in the context of smart agriculture, the broader applicability and effectiveness of additional low-code patterns remain unexplored. This limitation implies that the presented findings may not encompass the full spectrum of solutions that could enhance various aspects of smart agriculture platforms.

2.2 Second Limitation:

The second limitation revolves around the specificity of the smart agriculture digital twin use case chosen for experimentation. The paper primarily concentrates on this particular use case provided by CybeleTech, which involves greenhouse modeling and crop management. This narrow focus may limit the generalizability of the results to other smart agriculture scenarios. To address this limitation, future work could broaden the scope of experimentation to include a more diverse set of smart agriculture applications, ensuring that the proposed low-code patterns are robust and effective across various agricultural contexts.

3 Synthesis:

The synthesis emphasizes the broad applicability and scalability of the proposed solution. The adaptable low-code patterns, especially the Edge ETL pattern, can be extended to various hybrid (cloud/edge) applications within the agricultural sector and beyond. Key technologies such as Node-RED and edge devices like Raspberry Pi contribute to the feasibility and effectiveness of the proposed solution. Future work could involve comprehensive evaluations of additional low-code patterns, development of new patterns for lightweight analytics, and exploration of diverse smart agriculture scenarios to enhance system performance and capabilities. The synthesis underlines the potential for addressing emerging challenges across different domains, showcasing the versatility of the proposed low-code approach.