TU Delft

Delft University of Technology

Digital Twin-Based Hybrid PHM Framework for Monitoring Package-Level Degradation

Inamdar, A.S.; van Driel, W.D.; Zhang, Kouchi

Publication date
2023

Document Version
Final published version

Published in
Proceedings of the 33rd European Safety and Reliability Conference (ESREL 2023)

Citation (APA)
Inamdar, A. S., van Driel, W. D., & Zhang, K. (2023). Digital Twin-Based Hybrid PHM Framework for Monitoring Package-Level Degradation. In M. P. Brito, T. Aven, P. Baraldi, M. Cepin, & E. Zio (Eds.), *Proceedings of the 33rd European Safety and Reliability Conference (ESREL 2023)* (pp. 33-33). Research Publishing.

Important note
To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright
Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy
Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.

This work is downloaded from Delft University of Technology.
For technical reasons the number of authors shown on this cover page is limited to a maximum of 10.

Green Open Access added to TU Delft Institutional Repository

'You share, we take care!' - Taverne project

https://www.openaccess.nl/en/you-share-we-take-care

Otherwise as indicated in the copyright section: the publisher is the copyright holder of this work and the author uses the Dutch legislation to make this work public.

Proceedings of the 33rd European Safety and Reliability Conference (ESREL 2023)
Edited by Mário P. Brito, Terje Aven, Piero Baraldi, Marko Čepin and Enrico Zio
©2023 ESREL2023 Organizers. *Published by* Research Publishing, Singapore.

Digital Twin-based hybrid PHM framework for monitoring package-level degradation

Adwait Inamdar [1], Willem van Driel [1,2], GuoQi Zhang [1]

[1] Delft University of Technology, Mekelweg 5, 2628 CD Delft, The Netherlands.
E-mail: a.s.inamdar-1@tudelft.nl
[2] Signify, High Tech Campus 7, 5656 AE Eindhoven, The Netherlands.
E-mail: willem.van.driel@signify.com

Digital Twin can be broadly described as a continuously updated virtual representation of an object, system, or process which replicates all phases in the lifecycle of its physical counterpart. Originally conceptualized in 2003 [1], the term 'Digital Twin' came into existence after it first appeared in NASA's roadmap in 2010 [2]. The concept initially evolved within the framework of aerospace and manufacturing applications and has picked up a lot of traction in the past five years. Digital Twin is now commonly used in the context of products, processes, businesses, etc., and it has been embraced by many other industries such as healthcare and electronics.

The adoption of electronic devices and components in various applications has shown steep growth in last ten years, where some of the applications require them to withstand harsh environments. Thus, prognostics and health management (PHM) of microelectronics has gained importance more than ever. So far, the concept of Digital Twin has been implemented by contextualizing it for the respective use-case; and thus, it does not have a single fit-for-all definition or a standardized workflow. Therefore, it is crucial to clearly define a framework to implement a Digital Twin system for PHM of microelectronics. This presentation introduces such a framework adapted from a five-dimensional model [3] of Digital Twin.

First, physics-based and data-driven approaches of modelling and lifetime-prognosis are described, and their limitations on an individual basis are discussed. Then, a hybrid approach, which utilizes both of the aforementioned approaches as building blocks, is introduced along with its additional requirements such as the 'physics-of-degradation' models. Fundamental differences between a model and a Digital Twin of a product have been addressed, and three different complexity-levels (weak, cloud, and edge) of connections to the physical entity are discussed. The conflict of using edge and cloud-based computing for data-driven models, as well as the advantages of utilizing both of them together is also briefly touched upon. Lastly, an example of implementing the hybrid approach for monitoring temperature and humidity induced package-level degradation is presented.

Keywords: Digital Twin, prognostics and health management (PHM), electronic packaging, in-situ monitoring, physics of degradation.

References

1. M. Grieves, in *Virtually Perfect: Driving Innovative and Lean Products through Product Lifecycle Management*, (Space Coast Press, USA, 2011).
2. National Aeronautics and Space Administration (NASA), *Modeling, Simulation, Information Technology and Processing Roadmap*, (USA, 2010), (Rev. 2012).
3. F. Tao, W. Liu, M. Zhang et al. Five-dimension digital twin model and its ten applications. *Computer Integrated Manufacturing Systems, CIMS* , (2019).