PhD in Computer and Control Engineering

Research Title: Multi-Test and Validation Platform for AI-oriented Sensor System Integration

Funded by	SILK - FAW
Supervisor	Roberto Fedeli (SILK - FAW) – Luca Sterpone(Polito)
Contact	luca.sterpone@polito.it

Context of the research activity	Testing and Validation have been always a crucial part of application development for Automotive electronic systems. They involve different techniques for verifying and validating the features of the target systems. In the case of an heterogeneous sensor system; tests are preferred to be carried out in different stages of the development process and as early as possible to avoid extra costs due to the errors caught at later stages. Today, with the increasing system complexity, the cost of testing is also increasing in terms of resources and time, which introduce a critical impact against development constraints such as time-to-marked. Furthermore, the advent of more and more associated electronic components lead to an ever-increasing system complexity in high reliable automotive applications such as heterogenous system like Advanced Driver Assistance System (ADAS) and sensor fusion systems. The availability of new testing framework utilizing the Continuous Integration (CI) paradigm applied on Artificial Intelligence (AI) integrated system will provide an efficient and viable testing and validation method considering that some preliminary works already demonstrated the benefit on a real heterogeneous automotive system. This research proposal aims to target the different testing and validation phases developed for guaranteeing the correctness of the design of AI-oriented system for automotive applications. The activity performed in the research proposal may span from system behavioral level to Register Transfer Level (RTL) and down to post-synthesis/post-layout gate level, where the developed has fine observability and control over the internal behavior of the design. As the abstraction level goes down, the simulation results become more accurate w.r.t the real system, however, the cost in term of simulation time and resources increase rapidly along the scale of the target design. The activities performed in the research proposal will go towards two key pathways. The first one will target the high quality, reliable and safe automotive electronics testing and validation methodology applied to AI-oriented cores. The activity may be carried on using Virtual Platform (i.e. Synopsys Virtual Development Kit) implementing AI-algorithms as golden applications. The second one will target the physical component, evaluating the resilient implementation of AI algorithm on the modern generation of low-power and automotive oriented computing devices (e.g., Xilinx AI Engine Technology) by developing a new multi-test environment applicable directly to the physical device.

Objectives	The main scientific objectives of the research proposal are: - Reduce the effort needed to determine the possible failure point of an heterogeneous integrated system by identifying the functional failure within an hardware virtual model dedicated to AI algorithm and within a real device embedding an AI engine computing node. The objective will consider different operational conditions such as electronic glitches, missing data or jitter (advanced and postponed). These conditions will provide realistic constraints also considering side scenarios such as energy savings and intensive parallel work-load. - Develop an AI-oriented model of an integrated sensor system able to cope with the possible occurrence of failure and therefore using the metrics extracted from the developed tools to forestall the critical device and increase the overall reliability of the AI-oriented computing system.

Skills and competencies for the development of the activity	The research themes of Luca Sterpone are focused on the implementation of distributed computing system intelligence on edge-devices that are fundamental for the effective applicability of the Artificial Intelligence paradigm within the aerospace and automotive sector. In details, the research activity of Luca Sterpone specifically address reconfigurable computing and it spans over several multidisciplinary areas such computer-aided design, fault tolerance, radiation effects on component and electronic systems. The research projects correlated to the present proposals in the last years are: - [2014-2020] General Motors: “Development of software testing framework with a virtual hardware prototyping tools” - [2020-2021] Punch Torino SpA: “Development of software tool for the analysis of instructions and data dependency for SW validation and robustness” The main publications related to the present proposal in the last years are: - B. Du, S. Azimi, A. Moramarco, D. Sabena, F. Parisi and L. Sterpone, "An Automated Continuous Integration Multitest Platform for Automotive Systems," in IEEE Systems Journal, 2021 - T. Lange, A. Balakrishnan, M. Glorieux, D. Alexandrescu and L. Sterpone, "Machine Learning Clustering Techniques for Selective Mitigation of Critical Design Features," 2020 IEEE 26th International Symposium on On-Line Testing and Robust System Design (IOLTS), 2020 - S. Azimi, A. Moramarco and L. Sterpone, "Reliability evaluation of heterogeneous systems-on-chip for automotive ECUs," 2017 IEEE 26th International Symposium on Industrial Electronics (ISIE), 2017