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Author: Mr. Benjamin Haser
Universität der Bundeswehr München, Germany, benjamin.haser@unibw.de

Prof.Dr. Roger Förstner
Universität der Bundeswehr München, Germany, roger.foerstner@unibw.de

RELIABILITY OF NEURAL NETWORKS IN SPACE: A FAULT INJECTOR FOR SPACE RELATED PERTURBATIONS

Abstract

In recent years Artificial Intelligence (AI) has gained large popularity and replaced many traditional algorithms in speed and accuracy. Especially, in computer vision deep neural networks are the new state-of-the-art method, reaching human-level performance. Many industries already utilize AI and develop their own AI-based algorithm, by precisely adjusting them for the individual task. For example, in the aeronautics industry AI is currently used to detect faults in complex low-level surface structure of airplanes. Furthermore, AI has many more applications in computer vision such as classification, object detection, object change detection, image denoising, image super-resolution and dimensional reduction.
In the space industry Artificial Intelligence is slowly on its way from being researched towards being deployed onboard or within ground operations of spacecraft. A crucial characteristic, that delays the use of on-board AI is the unknown reliability and explain-ability of such techniques in comparison to traditional algorithms. Especially, the black box characteristics of deep neural networks and the gigantic amount of data and time that such models demand for training prevent its use in the space domain.
This study provides a framework which investigates the reliability of AI-algorithms based on deep neural networks by injecting space relevant faults in computer vision tasks, such es sensor damage and bitflips. More precisely, it can test the performance change dependent on the number of generated faults, its type and specific corrupted bits. Furthermore, it can measure the influence of the fault with regards to its position in the network (the transition between two neurons and the specific layer). First studies indicate that damage to a connected area within the camera has a bigger influence on the network than randomly placed pixel loss with the same number of lost pixel.