Machine learning as an alternative to thresholding for space radiation high current event detection

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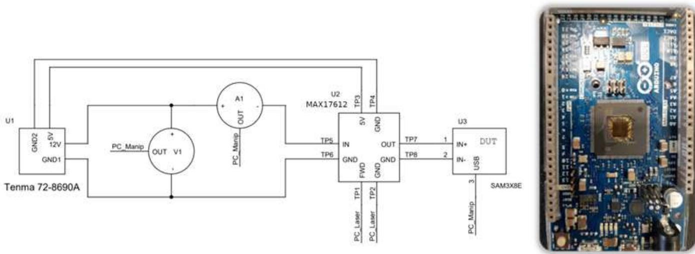
I. Context

- Single event latch-up results in high current events in an electrical component
- High current events can damage and compromise various functions of a microcontroller
- Small high current events are complex to detect
- Data based approaches and machine learning can improve high current event detection.

II. Experimental tests

- Laser tests to get high current event data
- On Atmel SAM3X microcontroller
- At CNES France

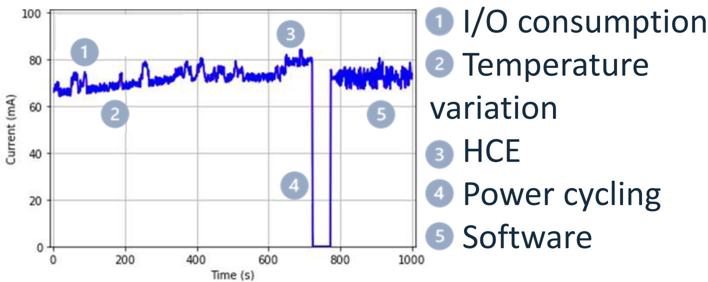


III. Simulation framework

- Simulated data created

$$I(t) = (f_{Nominal}(t,\bar{I}) + \sum_i f_{Load_i}(t,l_i,t_i,d_i) + \sum_j f_{Soft_j}(t,s_j,t_j,d_j) + \sum_k f_{Temp_k}(t,a_k,t_k,d_k) + \sum_l f_{HCE_l}(t,f_l,t_l,r_l)) * \sum_m f_{Reset_m}(t,t_m,d_m)$$

- Various current profile scenarios possible

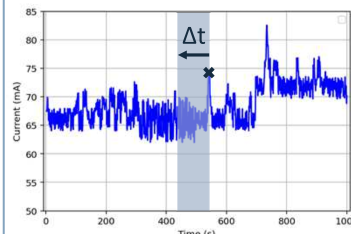


1. I/O consumption
2. Temperature variation
3. HCE
4. Power cycling
5. Software

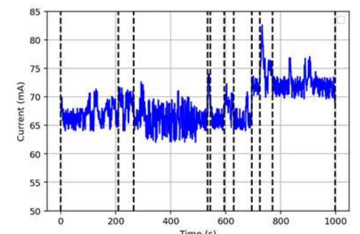
IV. Pre-processing

- Two time window methods tested

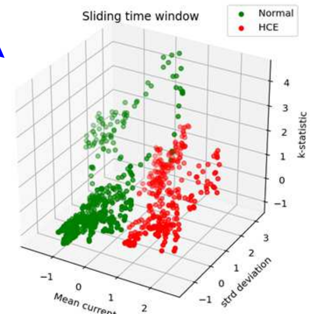
Sliding time window



Rupture time window

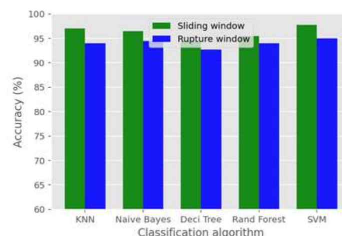


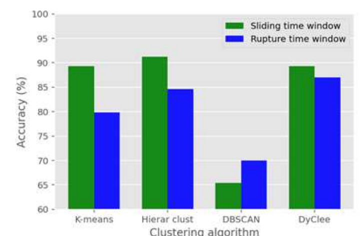
- Feature extraction with statistical calculations created with both normal and abnormal data



V. Detection results

- Classification and clustering





VI. Conclusion

Using both experimental tests and simulation, a method to gather consumption current data set is proposed. Then, various machine learning algorithms are tested to detect high current events. With overall results between 85% and 97% detection accuracy, this method improves small high current event detection that are normally imperceptible with today's threshold detection.

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