Tin Whiskers Simulation: Implementation Review

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Abstract

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1 Introduction

This paper will detail team Ram Logic's points of proposed implementation for clarification at the request of subject-matter expert (SME) Jay Brusse. In the tin whisker risk-analysis program, Monte-Carlo simulations are run with lognormal distributions of metal whiskers with parameters, σ and μ. **Unity** uses a CPU-bound implementation of the Nvidia **PhysX** physics engine [1][2]. As a result, Monte-Carlo simulations come at a significant time expense.

Considering two use-cases, tooling to determine the validity of PCB construction and iterative PCB design analysis, this program may benefit from simulation time reduction and fine-grained physics implementation.

2 Metal Whisker Simulation Performance

Unity physics simulations as defined by *Unity Technologies* are CPU-bound. To better understand impact as a measure of time expense to total metal whiskers dropped, Monte-Carlo simulations were run in an environment utilizing the RTX 4070 and AMD Ryzen-5600x. Parameters for Monte-Carlo simulations against total time taken is modeled:

Trial	PCB File	Total Whiskers k	Time (mm:ss)
1	Simple-PCB	100	00:10.51
2	Big-Split-PCB	100	00:14.23
3	Simple-PCB	500	02:00.81
4	Big-Split-PCB	500	02:15.15
5	Simple-PCB	1000	05:09.87
6	Big-Split-PCB	1000	06:12.41

Table 1: Monte-Carlo Simulation Results: Params(Monte-Carlo-n=50, len-$\mu = 5$, len-$\sigma = 0.15$)

Time expense per trial for Monte-Carlo simulations with n=50 with variable total whiskers count, k, are displayed in Table 1 above. There is a significant difference between the Simple PCB and Big Split PCB with Big Split PCB taking up to about $\frac{7}{5}$ the time of Simple PCB.

From the Monte-Carlo simulations, we can see PCB complexity has significant impact on simulation time. This is a result of collision and short detection logic utilizing extra CPU processing power. Additionally, PCB models within the whisker simulation modelling software may be relatively simple in comparison to real-world use-cases. For instance, typical computer motherboards are far more complex. Simulation time evidently rises with complexity, and

Trial	Total Whiskers k	Time (mm:ss)
1	100,000	00:09.22
2	200,000	00:12.27
3	1,000,000	00:42.91

Table 2: Monte-Carlo Simulation Results: Params(len-$\mu = 5$, len-$\sigma = 0.15$, particles=7)

utilizing hardware to handle that complexity is a factor that may determine the success of this project.

In the same environment, NVIDIA RTX 4070 and AMD Ryzen-5600x, using the high-fidelity physics framework, NVIDIA warp, there is a significant increase in performance. The following were implemented in a simplified physics engine:

- Time step: Δt = 0.01
- Variable whisker particles.
- Acceleration of gravity, 9.81 m/s^2.

Note: There is no PCB, mechanical vibration, whisker width, or collision detection simulation. Expect double or triple simulation in Table 2 as complexity is introduced; Monte-Carlo simulation is not used.

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