Paper: A Vehicle Crash Simulator Using Digital Twin Technology for Synthesizing Simulation and Graphical Models

Motivation: The purpose of this paper is to shed light on the utility and constraints of computer-based vehicle simulators while introducing a potential remedy for these limitations. It proceeds to underscore the deficiencies found in current simulators, particularly their lack of emphasis on simulating accidents and their challenges in replicating vehicle collisions.The principal incentive is to introduce the concept of a novel vehicle crash simulator designed to surmount these limitations. The suggested simulator is delineated as comprising simulation and animation components, with the objective of crafting and simulating vehicle and environmental models. The driving force is to underscore that this innovative simulator provides a more comprehensive solution, capable of generating outcomes involving both collisions and non-collisions based on the speeds of vehicles at an intersection, a feat that current simulators grapple with. Essentially, the motivation is to address current deficiencies and introduce a promising alternative for enhancing the capabilities of vehicle simulators.

Contribution: The primary focus of this contribution is to address the significance of software technology in the automobile industry, particularly in the development of vehicle simulators for purposes like fuel efficiency analysis, vehicle collision modeling, and vehicle control. The paper emphasizes the need for simulators that not only simulate vehicle crashes but also provide a visual representation of the results, making them more accessible to a wider audience. It utilizes a model repository to synthesize and simulate vehicle and road map models, creating a comprehensive approach to representing vehicle crash scenarios.The key contributions of this work are outlined as follows:
1.Simpy-based simulation for accurately simulating vehicle collisions.
2.Unity-based animation for visually representing collision scenarios using simulation results. The main goal of this contribution is to enhance the understanding and visualization of vehicle crash scenarios, making them more accessible and informative for various stakeholders in the automotive industry.

Methodology:The study's methodology involves creating a vehicle crash simulator that unites simulation and animation components. The process includes:
Model Repository: The simulator contains a model repository with two sections - one for vehicles and one for the environment. Vehicle models are crafted using Simpy, a Python-based discrete-event simulation, with parameters like weight, dimensions, and engine type.
Collision Modeling: The simulator defines collision points based on 12 vehicle positions, predicting damage in at least one point in the event of a collision between two vehicles.
Simulation Component: This part synthesizes models from the model repository and runs them using the Simpy engine. It considers various parameters and event scheduling to simulate different vehicle crash scenarios.

Animation Component: The animation component receives simulation results and uses Unity to create 3D models, visually representing the vehicle crash scenarios.

Conclusion: The proposed simulator presented in the passage addresses this limitation by combining simulation and animation components to represent vehicle crashes. The simulator's key contributions are Simpy-based simulation for collision simulation and Unity-based animation to visualize collision results effectively. In future work, the passage mentions plans to further study simulators, incorporating vehicles and experimental parameters. Additionally, it aims to explore the automatic generation of 3D animation environments. Overall, the passage introduces a simulator designed to improve the representation of vehicle collisions in a cost-effective and time-efficient manner and outlines its potential contributions and future research directions.