Available

Shield-X Technology Inc.

Dr. Farid Golnaraghi, PhD, PEng, Professor, Mechatronic Systems Engineering
Adrian Wikarna, MASc, Engineering Manager, Shield-X Technology Inc.
Dr. Mohammad Narimani, PhD, PEng, Senior Lecturer, Mechatronic Systems Engineering

---

Shield-X Technology Inc., a spin-off from Simon Fraser University (SFU), is dedicated to advancing helmet protection technologies to mitigate the sharp twisting and compression of the brain during impacts, a leading cause of concussions in various settings, including sports, occupations, industries, and the military. The impact performance of safety helmets is influenced by several critical parameters and design characteristics, including material composition, impact liner, helmet shell design, helmet shape and size, and helmet weight.

The primary objective of this capstone project … identify the most influential parameters/features affecting impact performance … safety helmets, and secondly, to employ machine learning models for precise prediction of impact outcomes across various helmet designs. The overall goal is to revolutionize the testing paradigm, minimizing the necessity for additional rounds of physical testing, and concurrently enhancing the reliability of safety assessments. A critical challenge within this project lies in devising a systematic process to identify and select all pertinent mechanical, material, and inter-related features that exert a significant influence on the impact performance of safety helmets.

:

The project will be including the following steps:

Design and implement a comprehensive set of impact tests for each helmet brand and size. This test set will encompass a wide range of helmet impact scenarios, including different orientations and speeds. The focus is on measuring resultant rotational accelerations during these scenarios. The data collected from this test set will be instrumental in identifying key features that significantly impact the performance of helmets during impacts. This step is foundational to the subsequent algorithm development.

Develop a machine learning architecture specifically tailored to the characteristics of helmet impact response prediction. This involves selecting and validating the input features identified in the feature extraction step. The desired outputs include resultant rotational acceleration and reduction impact percentages. The algorithm aims to establish a predictive model that can generalize across various helmet designs. This step is crucial in creating a robust and reliable predictive tool.

Evaluate the trained machine learning algorithm using a separate set of data to assess its performance and generalization capabilities. This testing and evaluation phase will provide insights into the model's accuracy and effectiveness. Adjustments to the model will be made as necessary to optimize its predictive capabilities. This iterative process ensures that the platform achieves high accuracy in predicting impact performance across diverse helmet designs.

Collaboratively design and implement a comprehensive set of impact tests covering different orientations and speeds for each helmet brand and size. The most significant part of this step is to select some feature that influence the outputs include resultant rotational acceleration and reduction impact percentages.

Collect data on resultant rotational accelerations from the impact tests and extract relevant features that significantly influence impact performance.

Develop a machine learning architecture, leveraging the identified features, to predict impact performance metrics such as resultant rotational acceleration and reduction impact percentages.

There might be a need to calibrate the testing rig to ensure accuracy and repeatability in impact simulations, creating a controlled environment for data collection.

Test the developed algorithm using a separate dataset, optimize the algorithm based on performance evaluations, and iterate as needed to enhance predictive accuracy.

Acquire hands-on experience in designing and implementing impact tests to collect relevant data for algorithm development.

Develop skills in data analysis to extract key features from the impact test data, understanding their significance in predicting impact performance.

Gain proficiency in applying machine learning techniques to develop predictive models tailored to the specific challenges of helmet impact response.

Learn iterative processes of testing and optimizing algorithms to enhance their predictive accuracy and generalization capabilities.

Foster collaborative skills by working across disciplines to integrate mechatronics, materials science, and machine learning in addressing a real-world problem.

Develop problem-solving skills in the context of safety engineering, contributing to advancements in helmet protection technologies.

This capstone project offers a unique opportunity for mechatronic students to contribute to cutting-edge advancements in helmet safety technology, bridging the gap between physical testing and predictive modeling. The multidisciplinary nature of the project ensures a holistic learning experience with practical applications in enhancing safety across various sectors.