ADAPT in SC: Investigating Structural Dynamic Identification Using Time Series Topological Features

Nickola Simpson[1], Daniel Salazar[2], Gurcan Comert[1], Austin R.J. Downey[3], Jason D. Bakos[3], Negash Begashaw[1]

[1]Benedict College, 1600 Harden Street, Columbia, SC 29204
Iowa State University, Ames, IA 50011
[3]University of South Carolina, Columbia, SC 29208

Abstract

❖This work performs an exploratory investigation into the utilization of Topological Data Analysis (TDA) for assessing the dynamic response of structures subjected to shock and impact events.

❖This approach is grounded in the observation that data generated from a system experiencing continuous vibrations when disrupted by a shock event present unique opportunities to study structural dynamics through a topological view.

❖Specifically, the paper focuses on the application of persistence diagrams, a key tool in TDA, to quantify and analyze the structural dynamics and their alterations post-shock events.

Forced Vibration and Shock Data

A dataset (https://github.com/High-Rate-SHM-Working-Group/Dataset-7-forced-vibration-and-shock) that looks at PCBs under continuous vibration before undergoing a shock event.

This dataset contains the measured acceleration data for an electronics unit under continuous vibration before undergoing a shock test. Figure 1 presents the experimental test configuration where the package is mounted on a Lansmont Model P30 shock test system designed to generate a continuous forced vibration before, after, and during a shock event here The accelerometer is a PCB Piezotronics 352A92 measured at 1 MS/s.

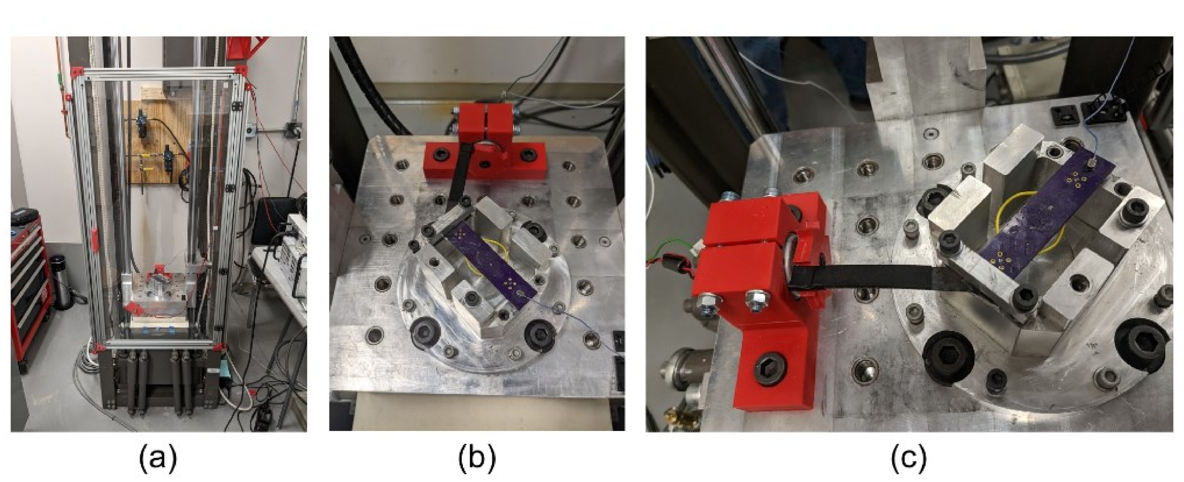

Figure 1: Image of the test, showing: (a) the shock test system, (b) the front view of the test setup on the drop table, and (c) the side view of the test setup on the drop table. (click the image to view a video of the test on YouTube).

Methodology

TDA was run on a 1000-point section of the data set. The sections are from vibration and shock states.

Results

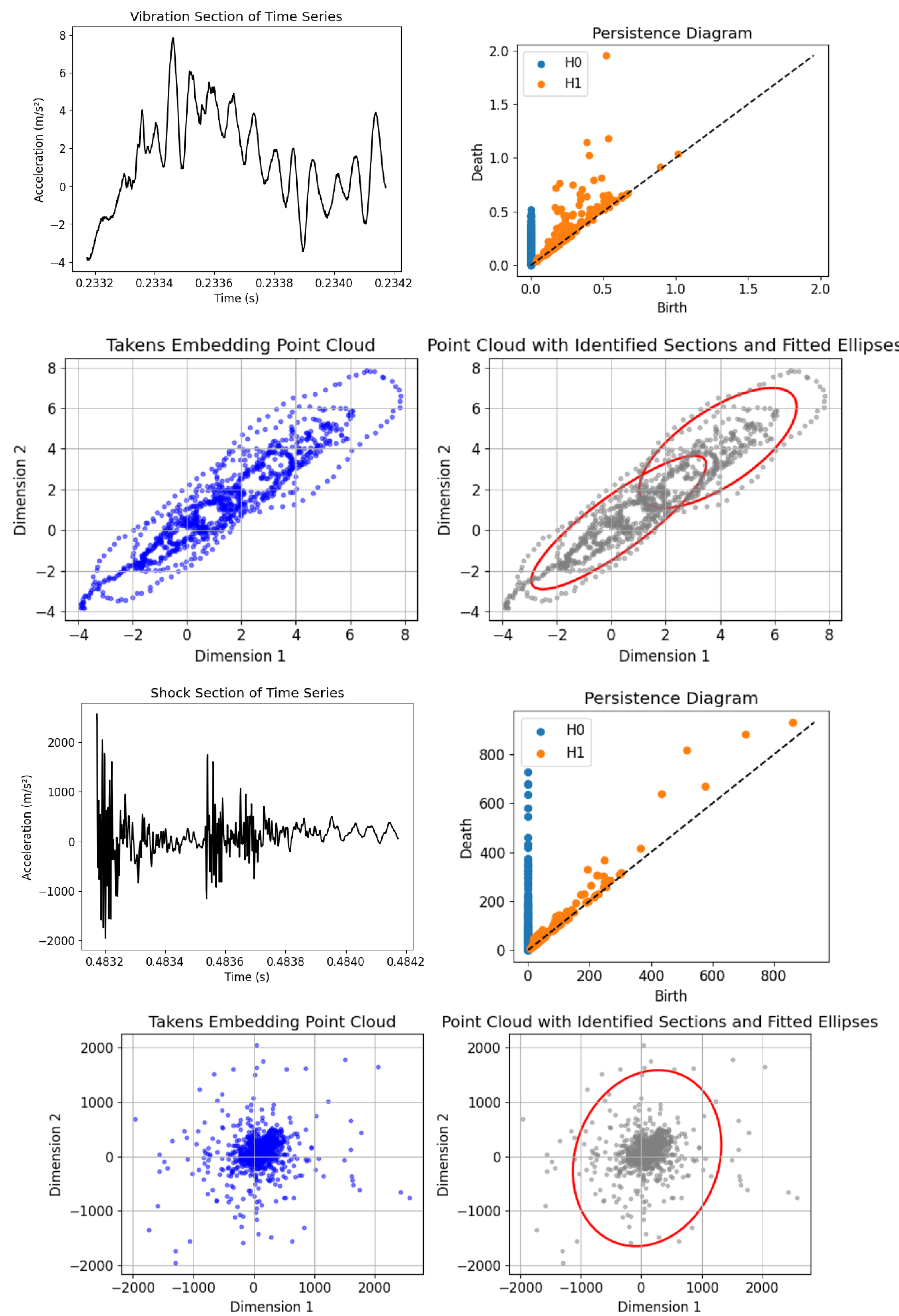

Figure 2: Example features for vibration and shock states

Conclusions and Future Work

❖This study explores a methodology for extracting and analyzing topological features from vibration data, particularly through persistence diagrams, which track the birth and death of topological features within the data as a function of time

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❖By examining these diagrams before, during, and after shock events, the study proposes a novel framework for identifying and quantifying damage or changes in the structure, emphasizing the exploratory nature of leveraging TDA for structural health monitoring.

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