Abstract

Water drops impacting cantilevered fibers is a highly complicated system as there are multiple factors that influence the outcome of the interaction. To compensate the complexity of the system, we used machine learning to assist in determining the output of the system. In our project, we especially investigate how much maximum deflection would a fiber string get when impacted by a water drop. To keep the experiment manageable, we have collected in total of 405 data for 3 different fibers with 5 features. Ensemble learning combines multiple machine learning algorithms to builds a better predictive model. The three algorithms applied are random forest regressor, gradient boosting regressor, and multi-layer perceptrons. Feeding the data into our machine learning algorithm, we were able determine feature’s significance and affect to each fiber’s maximum deflection.

Methods

- Data set are split into two group: random parameters (279 data) and DOE parameters (126 data).
- Experiment on random parameters is meant to give rough idea of features relationship and importance. Experiment on DOE parameters is meant for more accurate algorithm prediction.
- Results are calculated using a free video analysis and modeling tool software.

Experimental Setup

- High speed camera(Edgetronic) set directly in front of fiber
- The frame rate of the video 3000 fps
- Light source(GS Vitex LED array) to illuminate the experiment setup
- Adjustable platform on table to change effective length
- Adjustable platform on vertical stand to change drop height

Results

Expenned Fibers:
- Rubber string (B3)
- Ukulele 3rd string (U3)
- Ukulele 4th string (U4)

Experimented Features:
- Effective length (L)
- Drop Diameter (D)
- Drop Velocity (V)
- Wettability (W)
- Bending Stiffness (BS)

Ensemble Algorithm score:
- R2: 0.889
- RE: 123.605
- RMSE: 0.836

Conclusion

- Effective length is the most prominent factor which influence fiber maximum effective length.
- Material with high modulus of elasticity will have over all less maximum deflection.
- Effective length have a positive linear relationship, but starts to exponentially decay when effective length fall before certain value
- Drop diameter and Drop velocity have a positive linear relationship with all 3 fiber maximum deflection

Acknowledgements

The support for this work was provided by the National Science Foundation REU program under Award No. 1852002. Any opinions, findings, and conclusions and recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.