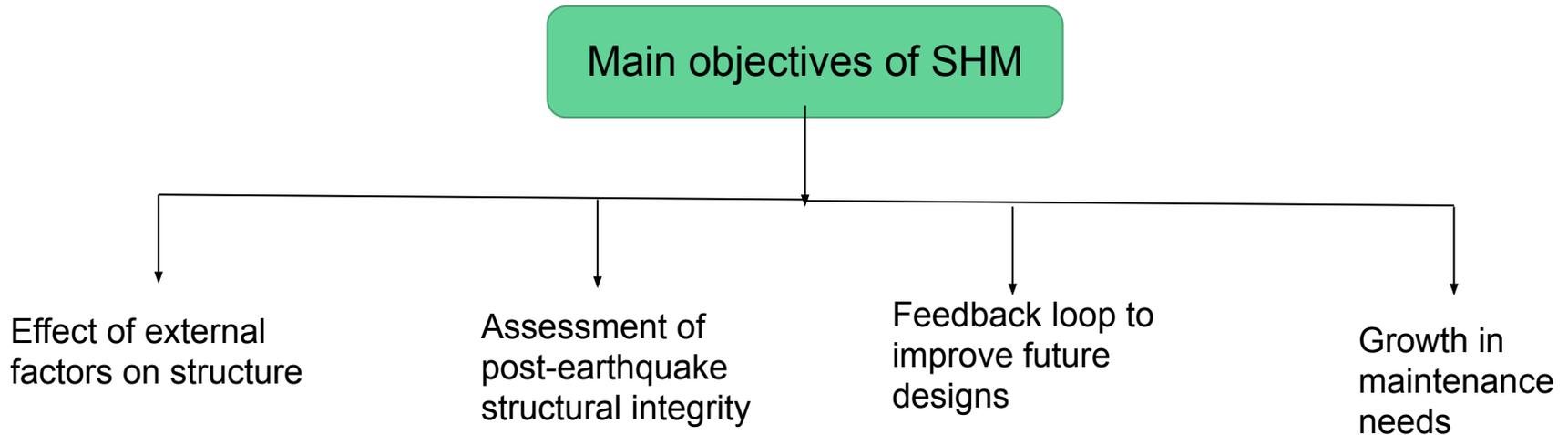


A Structural Health Monitoring System viewable in Augmented Reality

Final Presentation by Tanvi Ganu, 2017A3PS1901G
for CEERI, Pilani

What is Structural Health Monitoring?

- The process of implementing a damage detection and characterization strategy for engineering structures such as bridges and buildings.

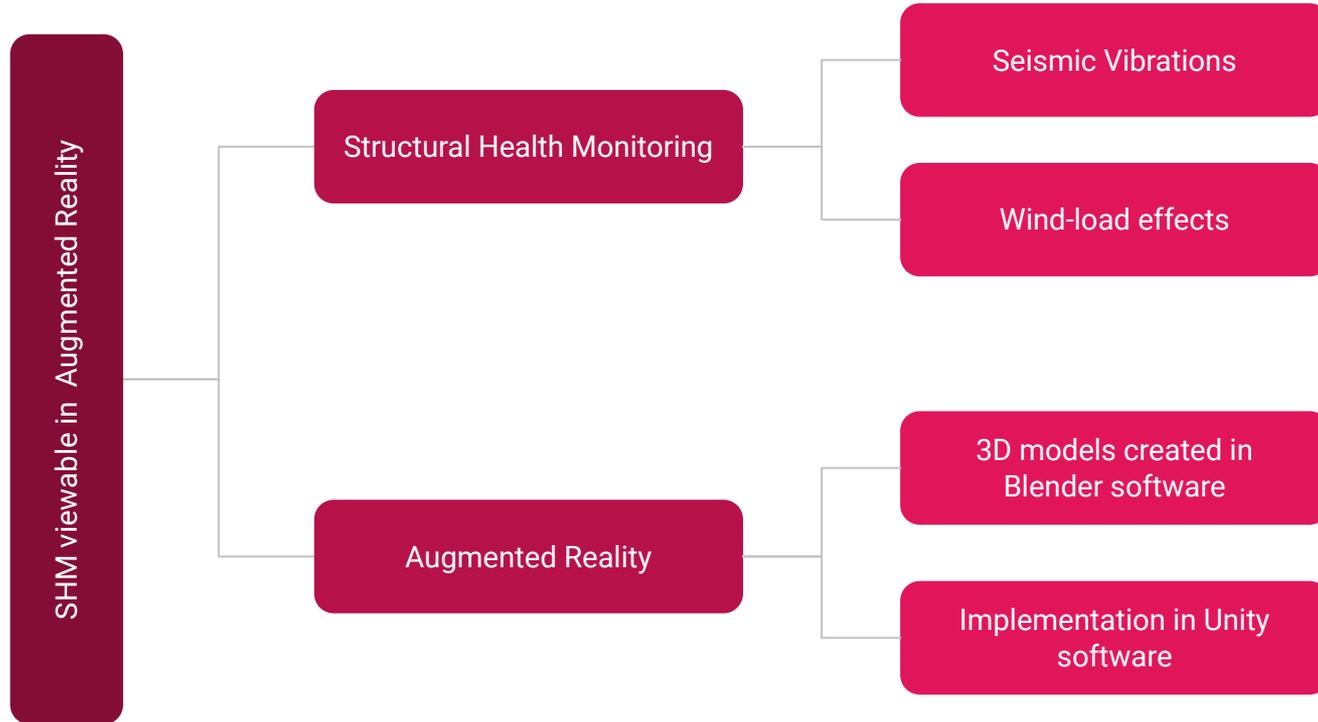


What is Augmented Reality?

- “An interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information.”
- Enables us to combine the virtual world and the real world by overlaying digital content and information onto the physical world.
- We have seen the impact of AR in many industries -
 - Gaming industry - example - Pokemon Go
 - Interior designing
 - Education sector



Overview of the Project



Preliminary research

Extensive preliminary literature reviews, research and experimentation confirmed the possibility of the following -

1. Real-time sensor data storage with the current software being used
2. Dynamic applications of force on structures in Unity
3. Introduction of flexibility in solids for -
 - a. Vibrations at certain frequencies
 - b. Deformations due to force applied
4. Mathematics of the Blender and Unity physics engines

Seismic Vibrations and Simulations



Preliminary Research on seismic activity

Literature Reviews and reading up on how seismic activity affects structures of various types and which factors must be taken into consideration.

Accelerometer testing

Testing the in-built accelerometers present in smartphones and the implications and accuracy of output of experimentation

Producing viewable seismic effects

Producing accurate vibrations as per the accelerometer data received

Using real Sensor data

Use real sensor data as input and test the system

Wind-load effects on structures

- There is an aerodynamic effect of strong winds on structures due to the force that acts upon the buildings.
- Wind also causes buildings to vibrate at frequencies that may prove harmful if it reaches the resonant frequency
- Mathematical calculations involved in this section included -
 - Force applied on structure based on wind-speed
 - Deflection at the free end of cantilever beam
 - Natural frequency of the structure
 - Wind-speed at which resonance will occur

Wind-load effects on structures



Preliminary Research

Research regarding the factors involved in wind-load effects on structures

Combining on-paper calculations with software available

Extensive research and use of the Unity and Blender physics engines to implement on-paper calculations on a digital platform

Building a User Interface and application in Unity

Building an easy-to-use dynamic user interface that makes appropriate calculations based on input parameters for a Cantilever beam

Structure specific data and dimensions

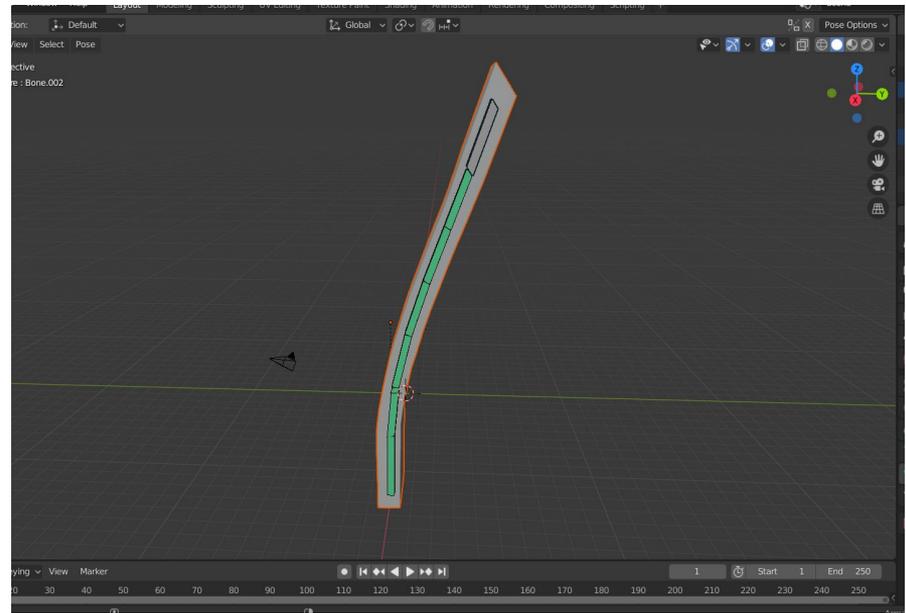
The application built can be tested on specific structures if their accurate dimensions are provided

Modelling in Blender

Designing a flexible cantilever beam -

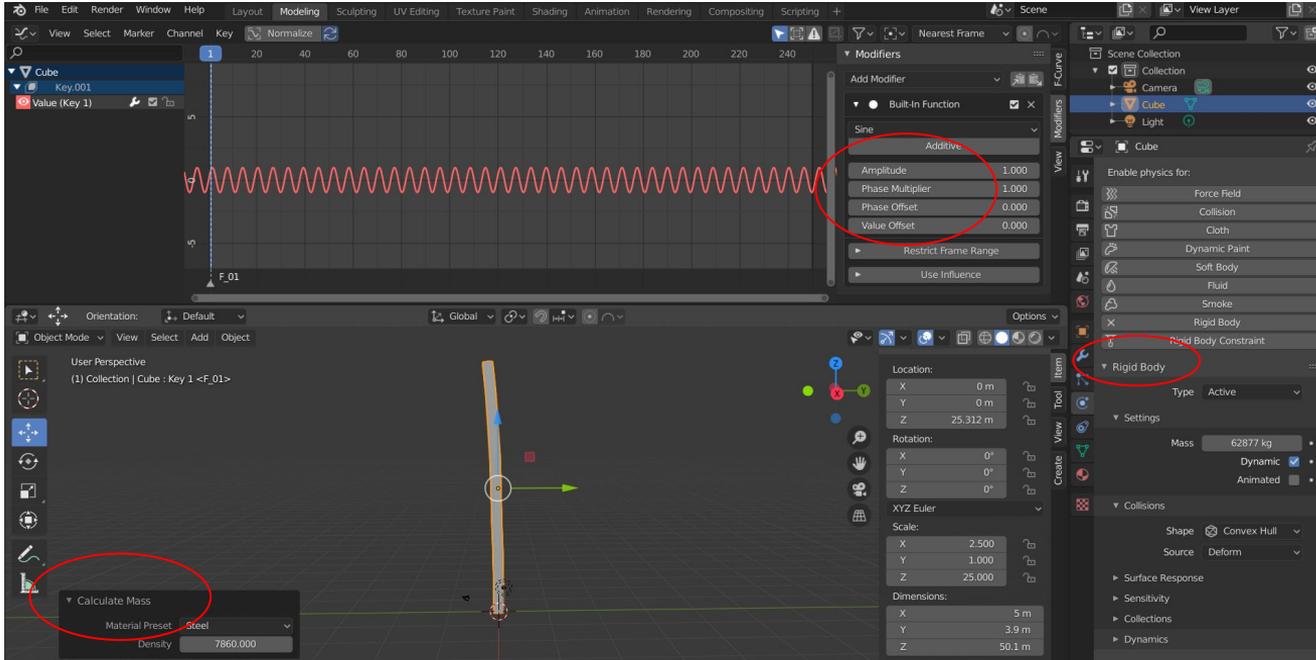


Using bones in Armatures



Using 'Bendy-bones' in Armatures

Blender Physics engine

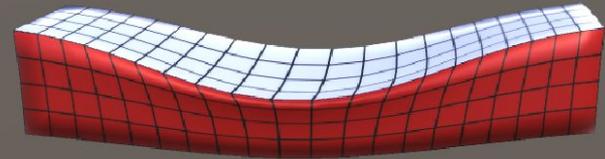
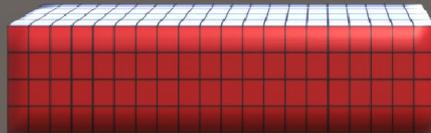


We are able to alter the following -

1. Density
2. Frequency
3. Material
4. Dimensions
5. Bounciness (elasticity)
6. Coefficient of friction

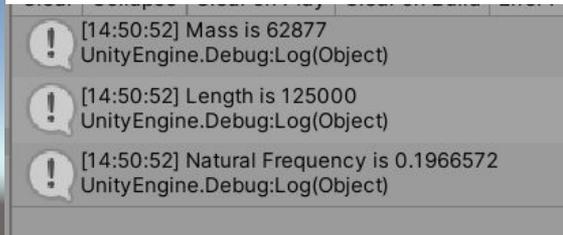
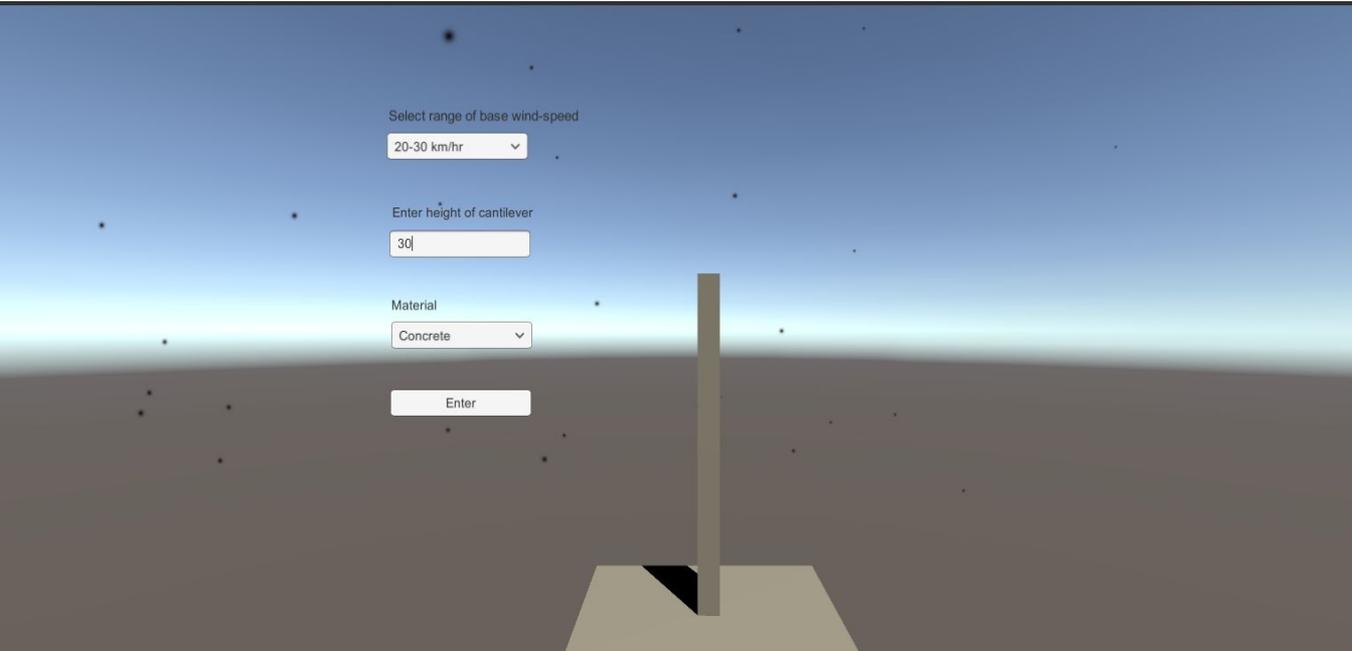
Use of Unity software

Unity helps you simulate physics in your Project to ensure that the objects correctly accelerate and respond to forces.



Mesh deformation due to application of external force achieved in Unity software

Unity User Interface and Implementation



Limitations and challenges faced

1. Lack of advanced physics engines
 - a. Unity and Blender are primarily made for gaming and animation applications
 - b. Advanced and physically accurate properties for materials are lacking
 - c. Scripts developed in C# with manual calculations covered up some of the disadvantages
2. The model, and hence the system will vary for each structure
 - a. This is a model specific system whose output will change as per the model
 - b. Hence, for accurate results regarding a particular model, we will need a 3D model of the structure being analyzed

Importance of the project

- This project is a stepping stone into developing model-specific monitoring system which is viewable in Augmented Reality.
- The literature gathered so far provides a strong base and a starting point to add as many factors to the project as we please
- It shows the positive possibility of physics engines of gaming engines such as Unity to be used for pure scientific use.
- Most importantly, an application has been designed to dynamically change variables and conditions as well as immediately calculate and visualize output

What I learned

- In-depth research of the physics engines, the possibilities and its limitations of Unity and Blender software
- The concept of Structural Health Monitoring, its importance and the current technology and mechanisms used for the same
- Scientific applications and practical uses of the Augmented Reality technology, apart from entertainment and training purposes.

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Thank You!