# COMPUTER GRAPHICS AND VIRTUAL REALITY

# COURSE PROJECT


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# CONTENT

# INTRODUCTION

- Digital twin - virtual model designed to accurately reflect a physical object.
- Used to study performance, issues, suggest improvements
- Based off real-time data

# PROBLEM STATEMENT

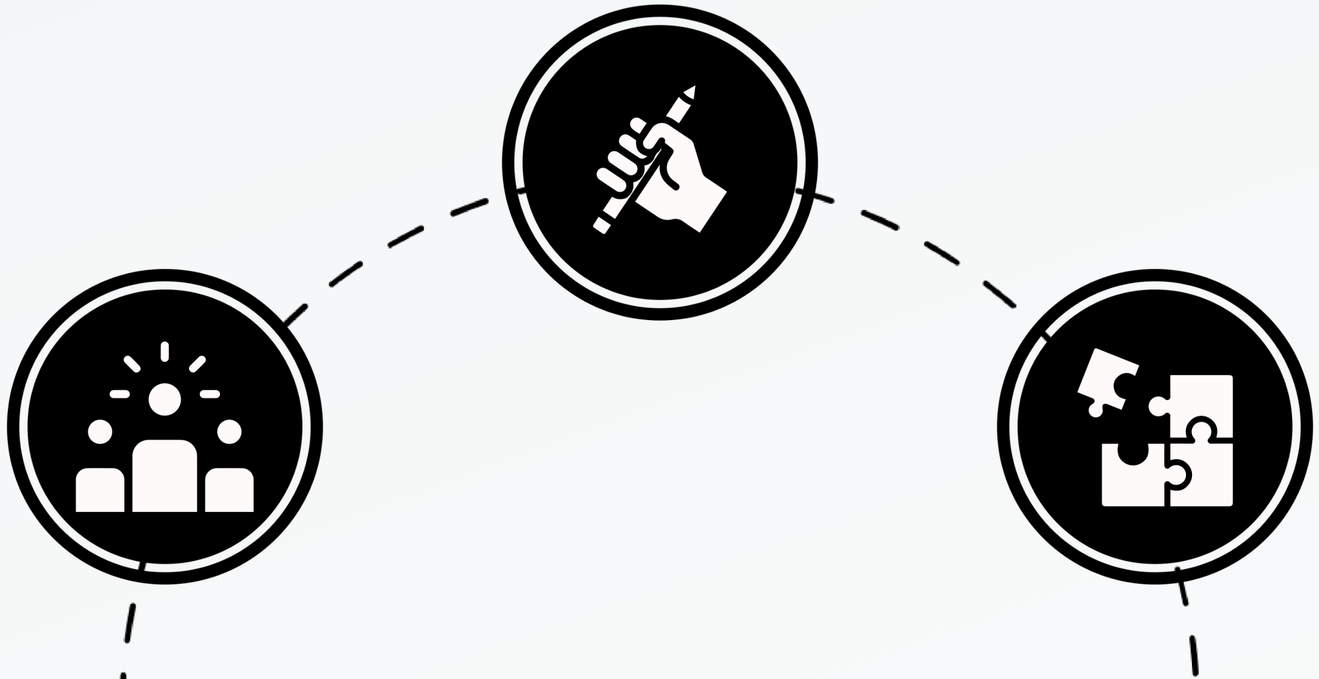
Creation of a Digital Twin of Windmill

# OBJECTIVES

**Simulating current state of windmill**

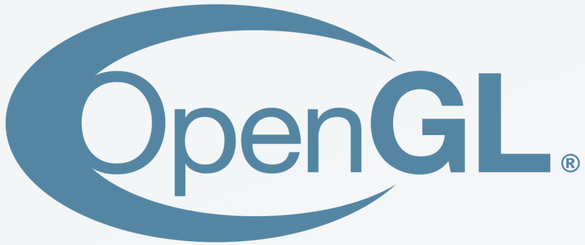
**To find optimal location for windmill**

**Power generation predictions**



# SOFTWARE & HARDWARE REQUIRENMENTS

## *Software*




Open GL: GLUT library
C compiler and editor (Visual Studio)
Library for Web request

## *Hardware*

A 64-bit Windows machine with win-32 API
Graphic card preferred but not mandatory

# METHODOLODY

## Graphics Implementation

- First, the object files were parsed and normal and vertices were saved.
- They were used in display function to draw triangles that combine to form a well defined object.
- Translation matrices and perspective projections were used for the same.
- Rotation matrices were used to rotate the blades of the windmill.
- The final touch was addition of lighting.

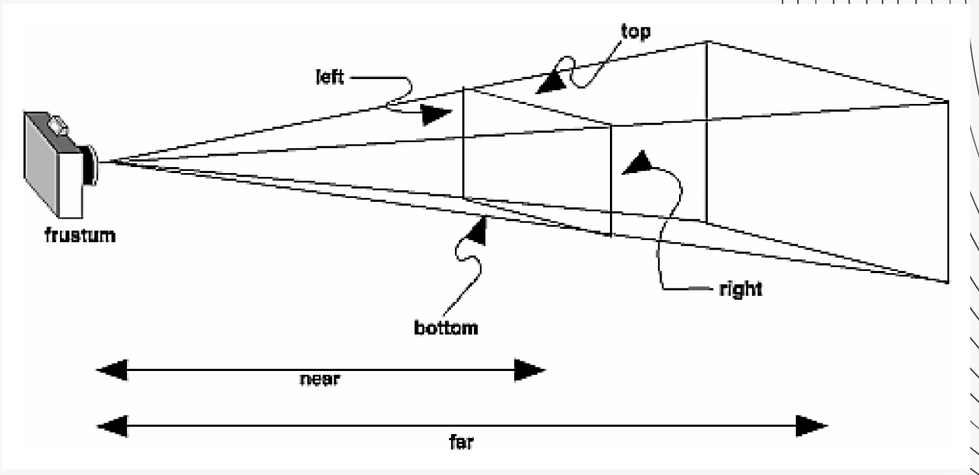
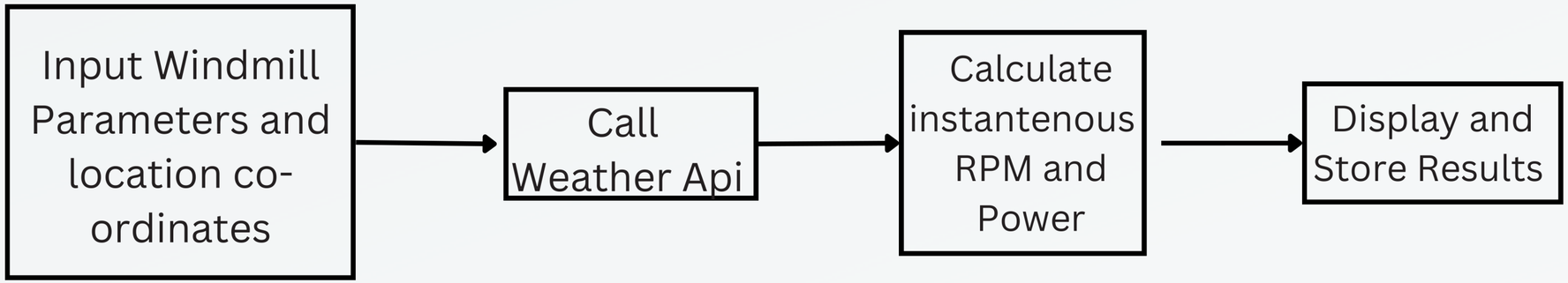



Image depicting perspective projection

# METHODOLODY




$$\text{Instantaneous Power} \propto \text{Velocity}^3 \cdot \text{Density} \cdot \text{Blade length}^2$$

- **Input Windmill Parameters and location co-ordinates:**

The windmill parameters like blade length, TSR, constants of losses, etc. and the co-ordinates  of the desired location are entered into a csv file.

- **Call Weather API:**

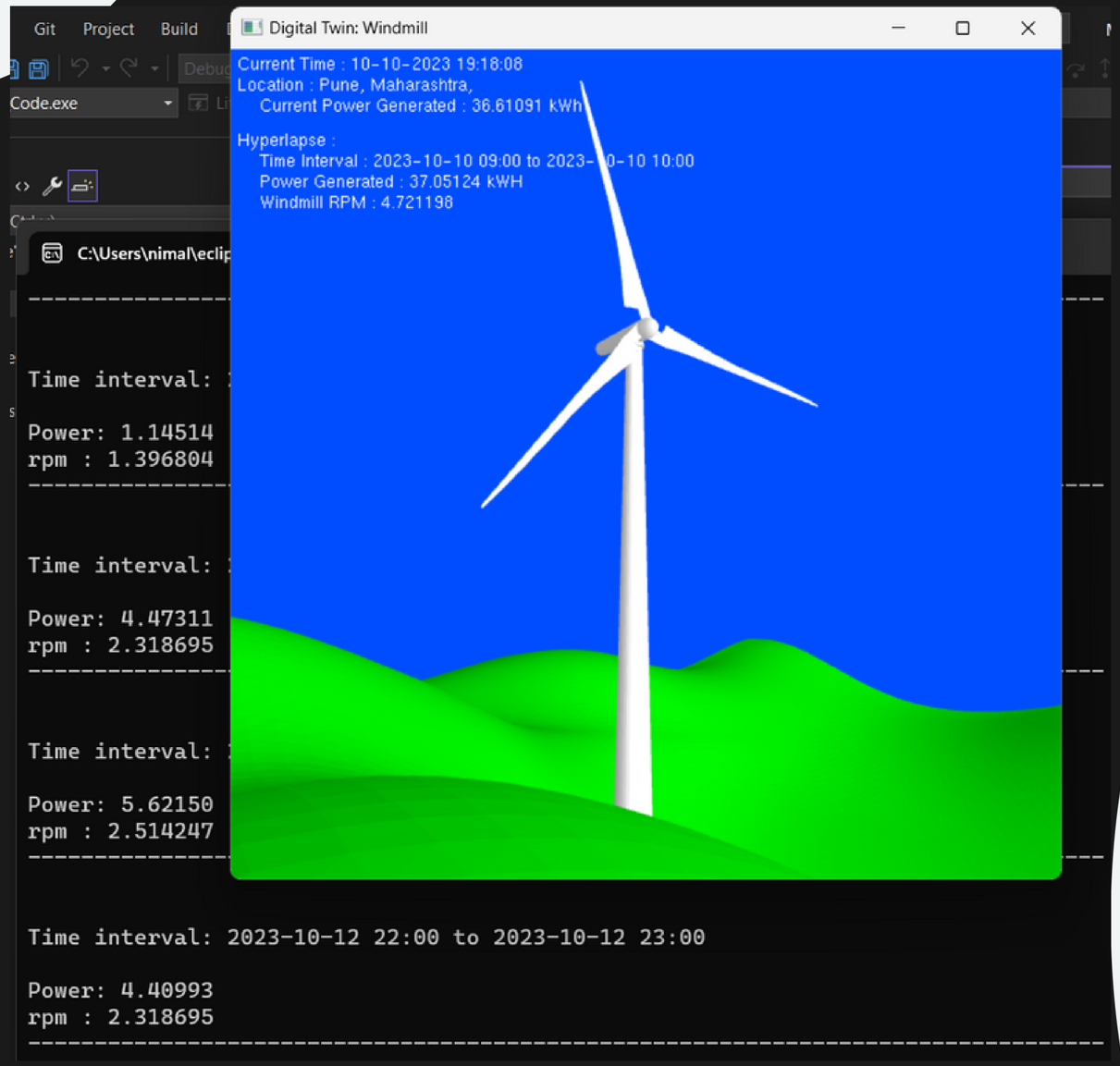
A weather API is called to obtain real-time values of factors affecting windmill performance. These values are parsed from a JSON file.

- **Calculate Instantaneous Power and RPM:**

Using the values obtained from weather API, average RPM and energy generated in an hour is calculated.

- **Display and Store Results:**

Calculated  results are stored in a csv file, while the instantaneous power and rpm is displayed on the screen.



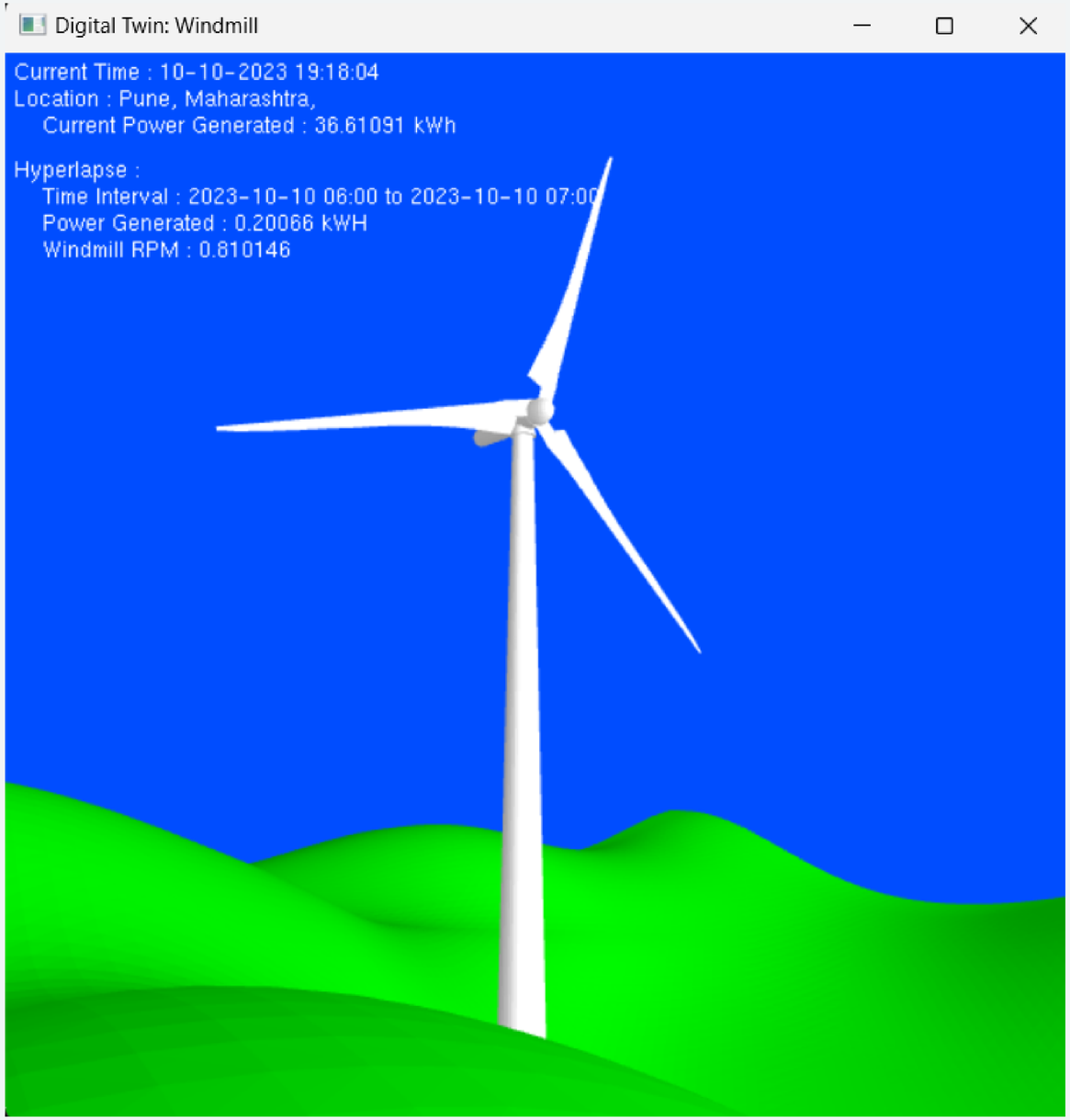

# RESULTS

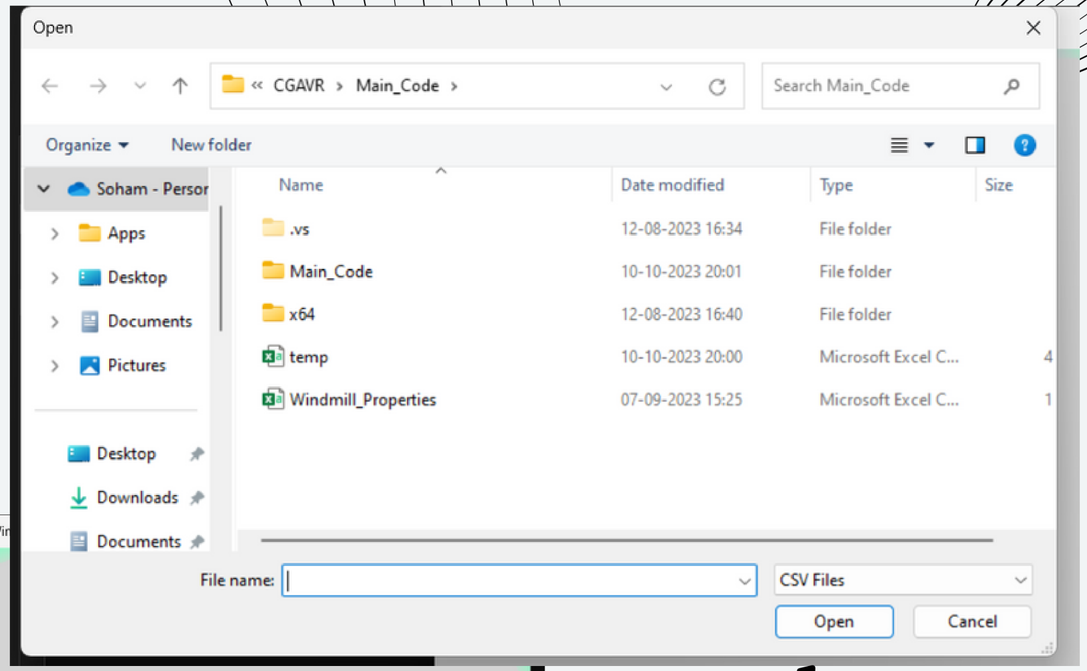
The image depicts the digital twin of the windmill.

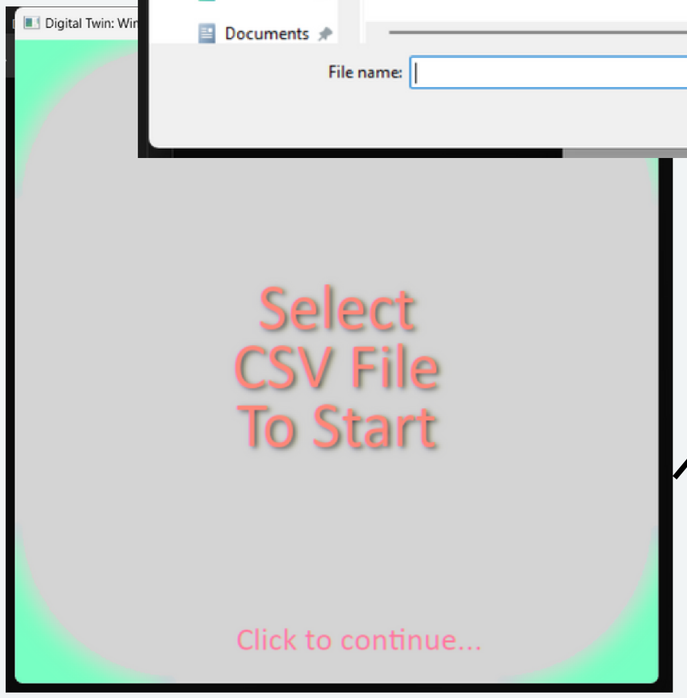
Along with it, we display the windmill parameters, current time, the RPM, and the power generated.

All the information generated saved in a CSV as shown in the results next page

# RESULTS


Digital Twin: Windmill
Current Time : 10-10-2023 19:18:04
Location : Pune, Maharashtra,
Current Power Generated : 36.61091 kWh
Hyperlapse :
Time Interval : 2023-10-10 06:00 to 2023-10-10 07:00
Power Generated : 0.20066 kWH
Windmill RPM : 0.810146


Open
CGAVR › Main_Code ›
Search Main_Code
Organize
New folder
Soham - Persor
Apps
Desktop
Documents
Pictures
Desktop
Downloads
Documents
Name
Date modified
Type
Size
.vs
12-08-2023 16:34
File folder
Main_Code
10-10-2023 20:01
File folder
x64
12-08-2023 16:40
File folder
temp
10-10-2023 20:00
Microsoft Excel C...
Windmill_Properties
07-09-2023 15:25
Microsoft Excel C...
File name:
CSV Files
Open
Cancel


Digital Twin: Wir
Select
CSV File
To Start
Click to continue...

# CONCLUSION

- Digital twinning of equipment used in renewable energy can be an effective source of monitoring them.
- Helps in reducing maintenance cost
- Accurate
- Scalable
- Based on real - time data

# References


- https://www.ibm.com/topics/what-is-a-digital-twin
- https://www.omnicalculator.com/ecology/wind-turbine
- https://learnopengl.com/

# Thank You