CAE Club & Astronomy Club
IIT Indore

CUBESAT PROJECT

Hands-On Experience in Designing,
Building, and Visualizing CubeSat Systems

INTRODUCTION

Objective:

- Developed a CubeSat to monitor weather patterns by measuring temperature and humidity

Key Features

- Design: Optimized for resilience and functionality, focusing on structural, thermal, and modal analysis.
- Payload: Equipped with sensors for real-time data collection.
- Interface: User-friendly GUI for data visualization.

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WORK STRUCTURE

Design & Analysis

- Responsible for structural, thermal, and modal analyses.
- Ensured load-bearing capacity and functionality under various conditions.

Hardware

- Managed sensor integration, PCB design, and 3D printing of the structure.
- Focused on assembling and testing the payload components.

GUI Development

- Designed the graphical user interface for real-time data visualization.
- Integrated sensor data into a user-friendly platform.

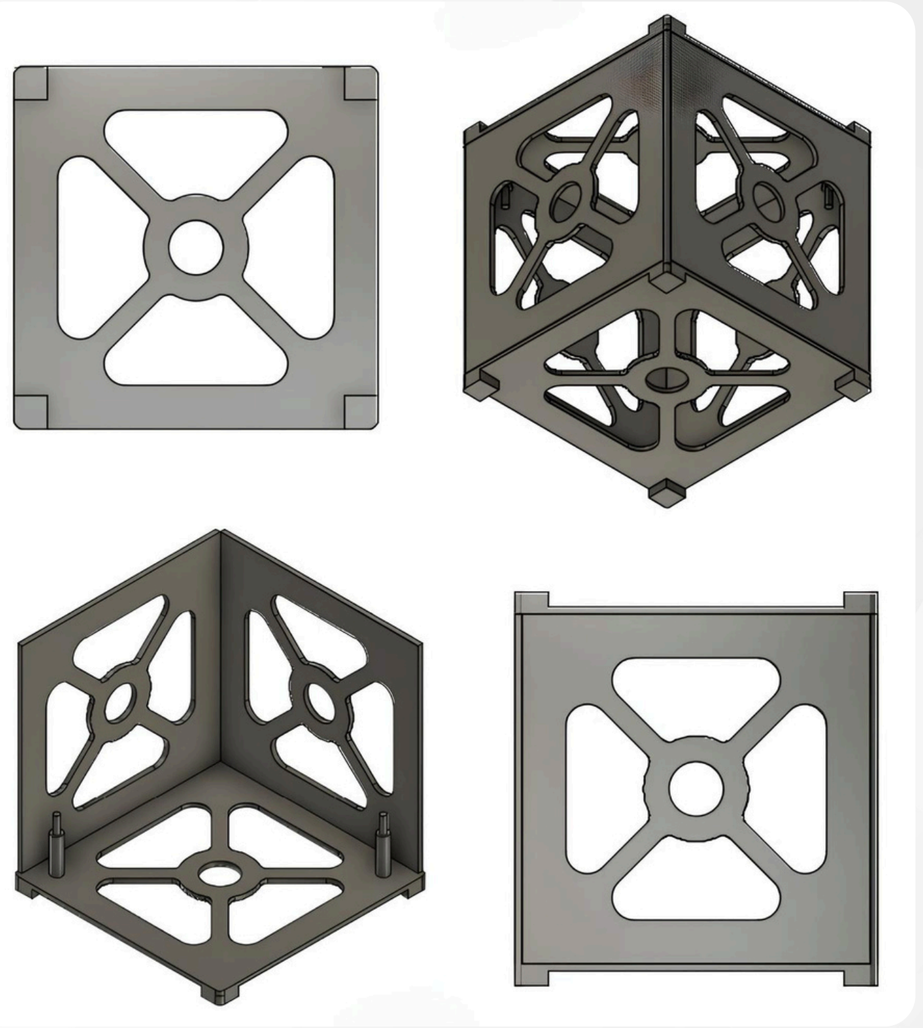
DESIGN
OF CUBESAT

Design Features:

- Structure: Compact 1U CubeSat (10x10x10 cm), designed for modularity and easy integration of components.
- Frame Configuration: "X" design with 6 frames for balanced stress and better integrity.
- Structural Features: Central hole for weight and thermal management, and circular shape to minimize cracks.
- Base Design: Eight square bases for stability and spring deployment.

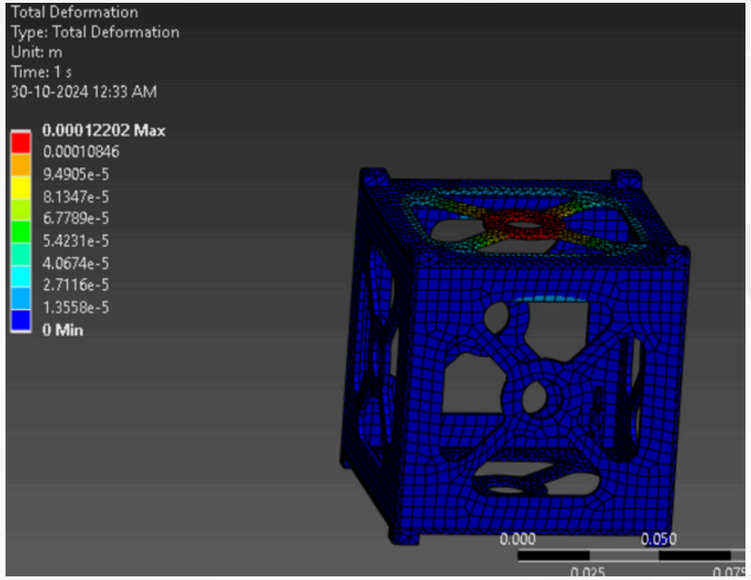
Optimization Goals:

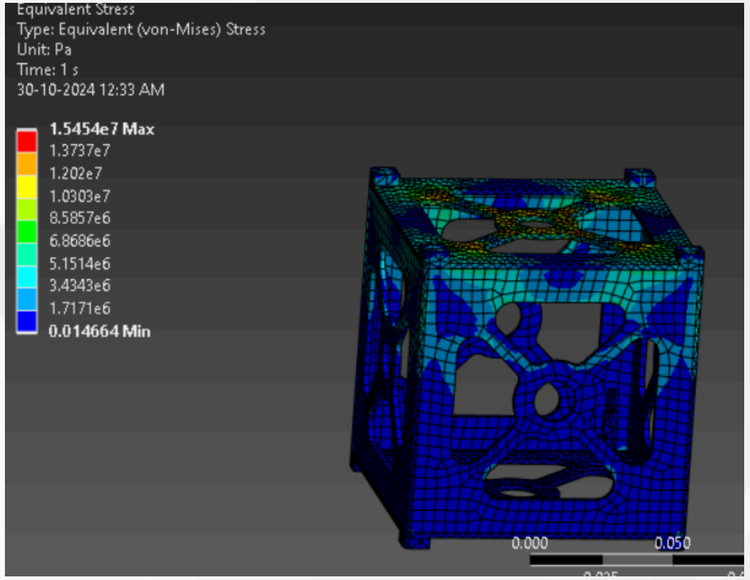
- Minimized weight while ensuring structural integrity.
- Maximized internal space for hardware and payload integration.



STRUCTURAL ANALYSIS

- Conducted structural analysis to ensure the CubeSat withstands launch conditions.
- Loads Applied: Launch acceleration: 3g, Spring force (during deployment) : ~60N, Impulse: 7N
- Stresses Found: Maximum stress = 15.45 MPa with 0.12 mm deformation (well within material limits).
- Factor of Safety applied: 1.4.



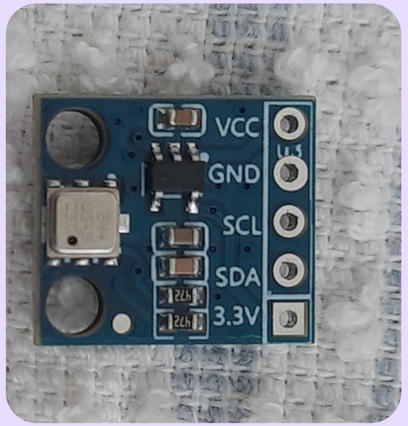


	Mode	Frequency [Hz]
1	1.	1157.6
2	2.	1160.1
3	3.	1205.8
4	4.	1206.6
5	5.	1216.3
6	6.	1362.7
7	7.	2026.5
8	8.	2034.3
9	9.	2368.4
10	10.	2613.7

MODAL ANALYSIS:

- Performed modal analysis to evaluate natural frequencies and avoid resonance during launch.
- Natural Frequencies Found: First natural frequency = 1157.6 Hz(well above critical range (around 100 Hz)).
- Conclusion: The design is safe from resonance-induced failure.

HARDWARE
SENSORS

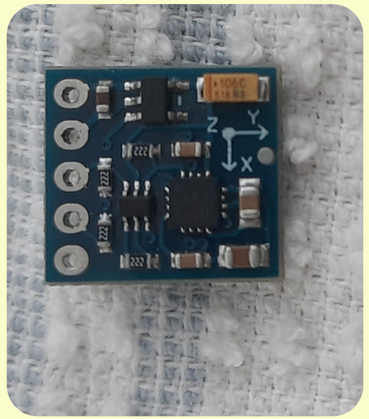


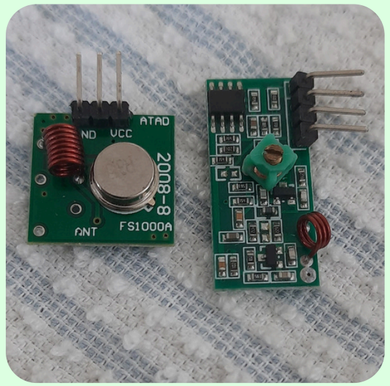
BMP180 (Pressure & Altitude Sensor):

- Purpose: Measures atmospheric pressure, temperature, and altitude.
- Function: Helps monitor environmental conditions in real-time.

GY-271 (Magnetic Sensor):

- Purpose: Magnetic sensor to detect the CubeSat's orientation with respect to Earth's magnetic field.
- Function: Used for attitude determination.



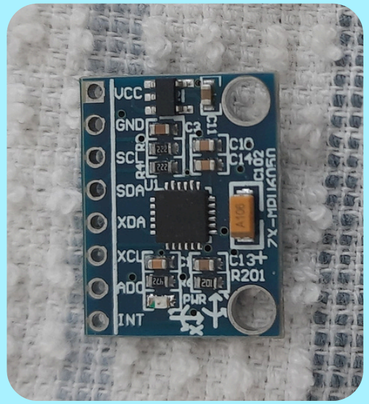


RF Transmitter-Receiver Module:

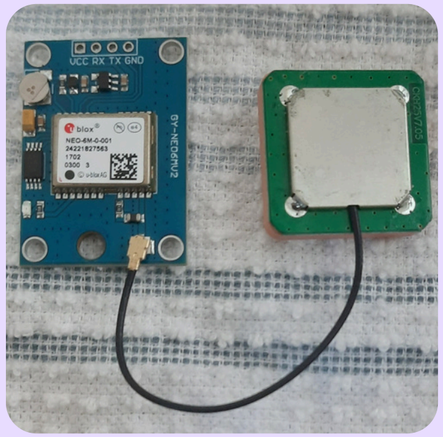
- Purpose: Enables wireless data transmission and reception.
- Function: Sends collected sensor data to the ground station for analysis.

GY-521 (Accelerometer-Gyroscope):

- Purpose: Measures acceleration and angular velocity.
- Function: Monitors CubeSat's motion and orientation during launch and operation.



HARDWARE SENSORS

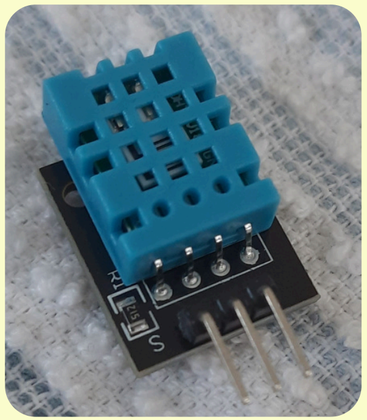


GY-NEO6MV2 (GPS Module):

- Purpose: Provides real-time location tracking of the CubeSat.
- Function: Helps determine precise position in orbit or on-ground testing.

DHT11 (Temperature-Humidity Sensor):

- Purpose: Measures temperature and humidity of the environment.
- Function: Aids in weather monitoring and environmental analysis.



Arduino UNO:

- Purpose: Microcontroller used to process sensor data and control CubeSat operations.
- Function: Collects sensor data and sends it to the Raspberry Pi for processing.

Raspberry Pi:

- Purpose: Serves as the primary processing unit for advanced tasks.
- Function: Processes sensor data, manages the GUI, handles RF transmission, and stores data locally if communication fails.

HARDWARE INTEGRATION AND ASSEMBLY

Hardware Integration:

- All sensors (BMP180, GY-271, GY-521, GPS, DHT11) connected to Arduino UNO for data acquisition.
- Arduino sends data to the Raspberry Pi for processing, storage, and GUI control.
- RF module used for wireless communication to the ground station

Testing:

- Validated each sensor module individually and within the integrated setup.
- End-to-end data flow tested: Sensor → Arduino → Raspberry Pi → RF Module → Ground Station.
- Tested GUI interface on the Raspberry Pi for real-time visualization of data.

SOFTWARE

GRAPHICAL USER INTERFACE

Understanding Graphical User Interfaces (GUI):

- A Graphical User Interface (GUI) allows users to interact with software applications through graphical elements like windows, buttons, and icons instead of text-based commands.

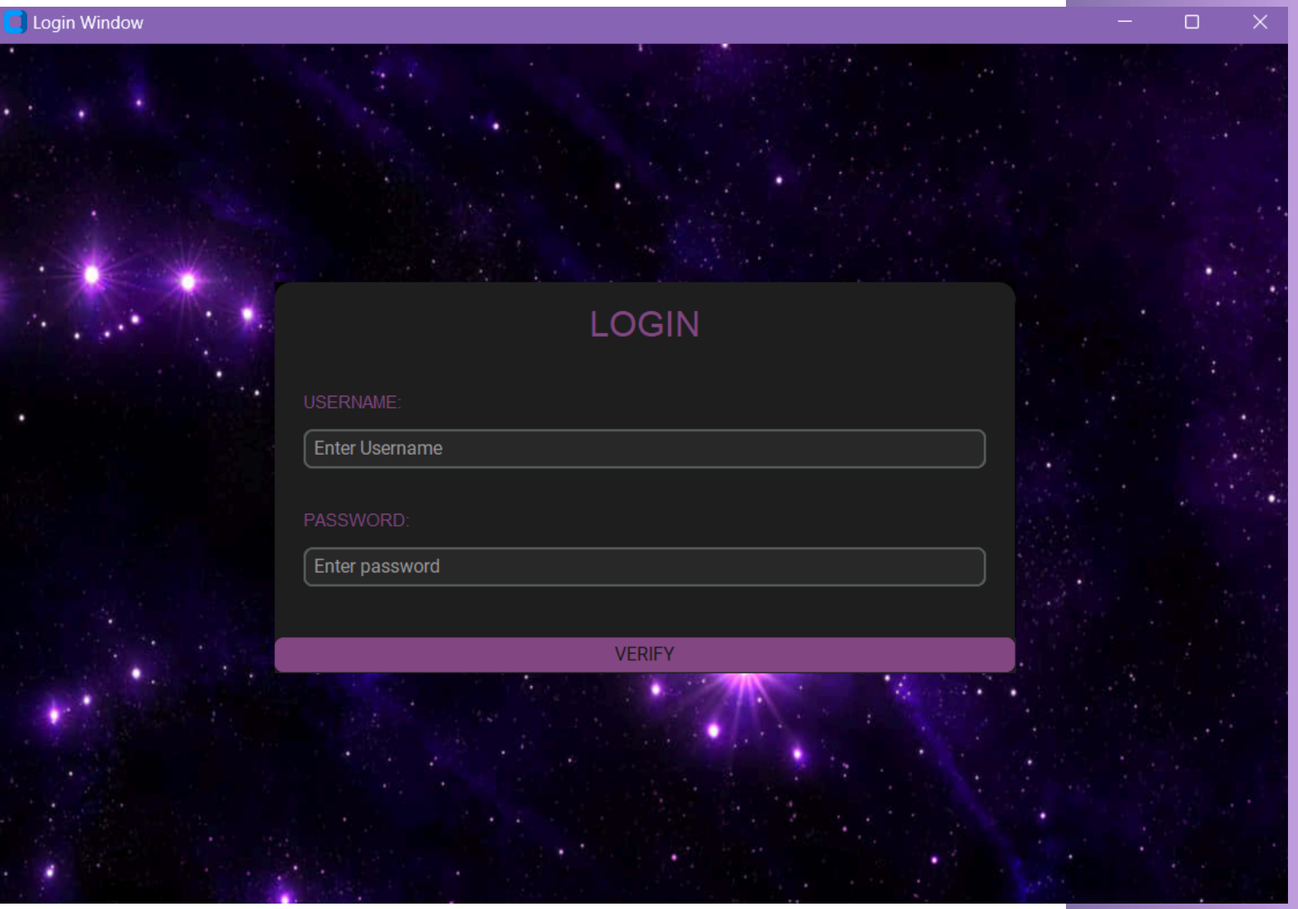
SOFTWARE

TECH STACKS

matplotlib

Major Libraries Used:

- Custom Tkinter/Tkinter
- matplotlib
- Pillow
- Pygame



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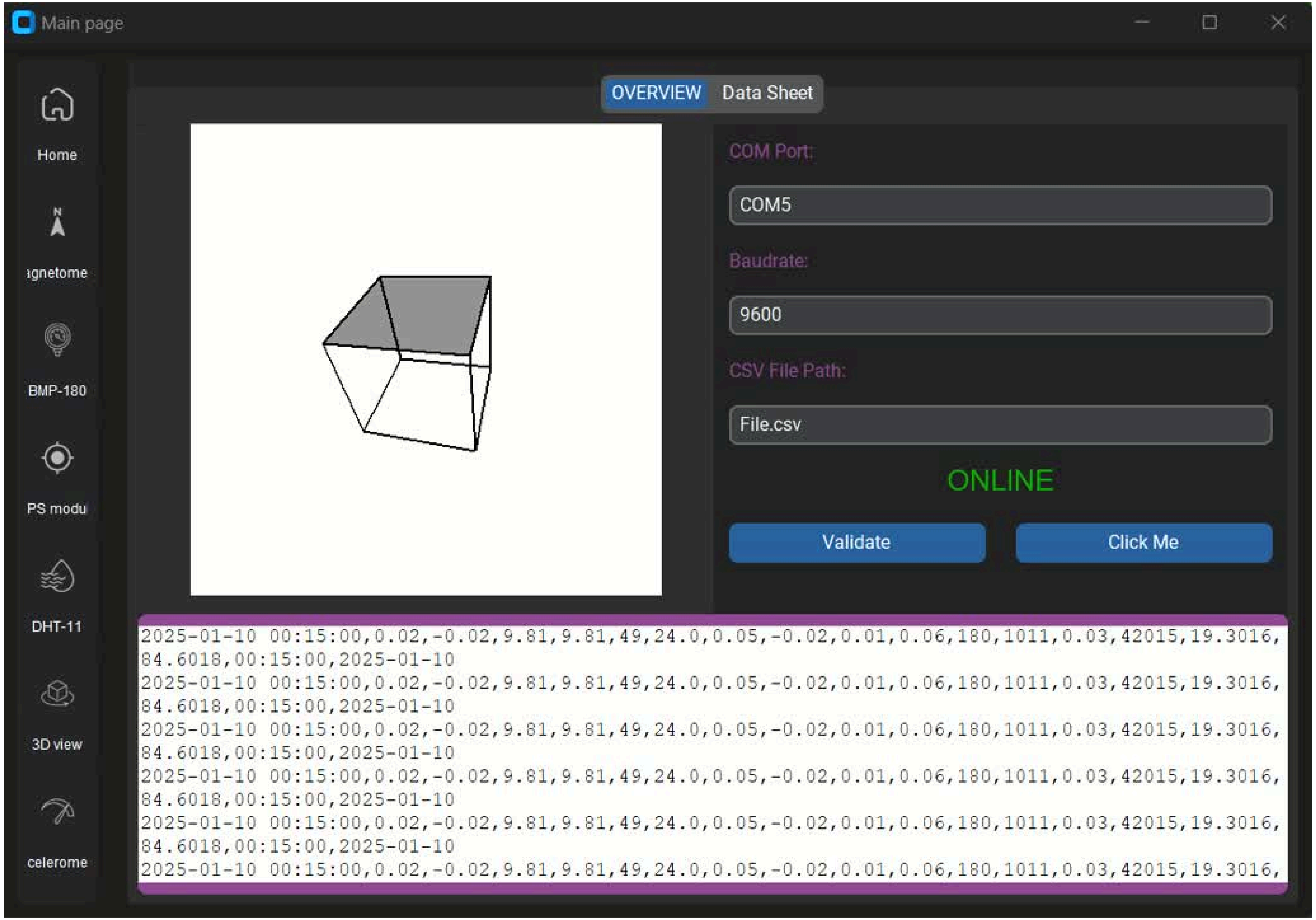
USER INTERFACE

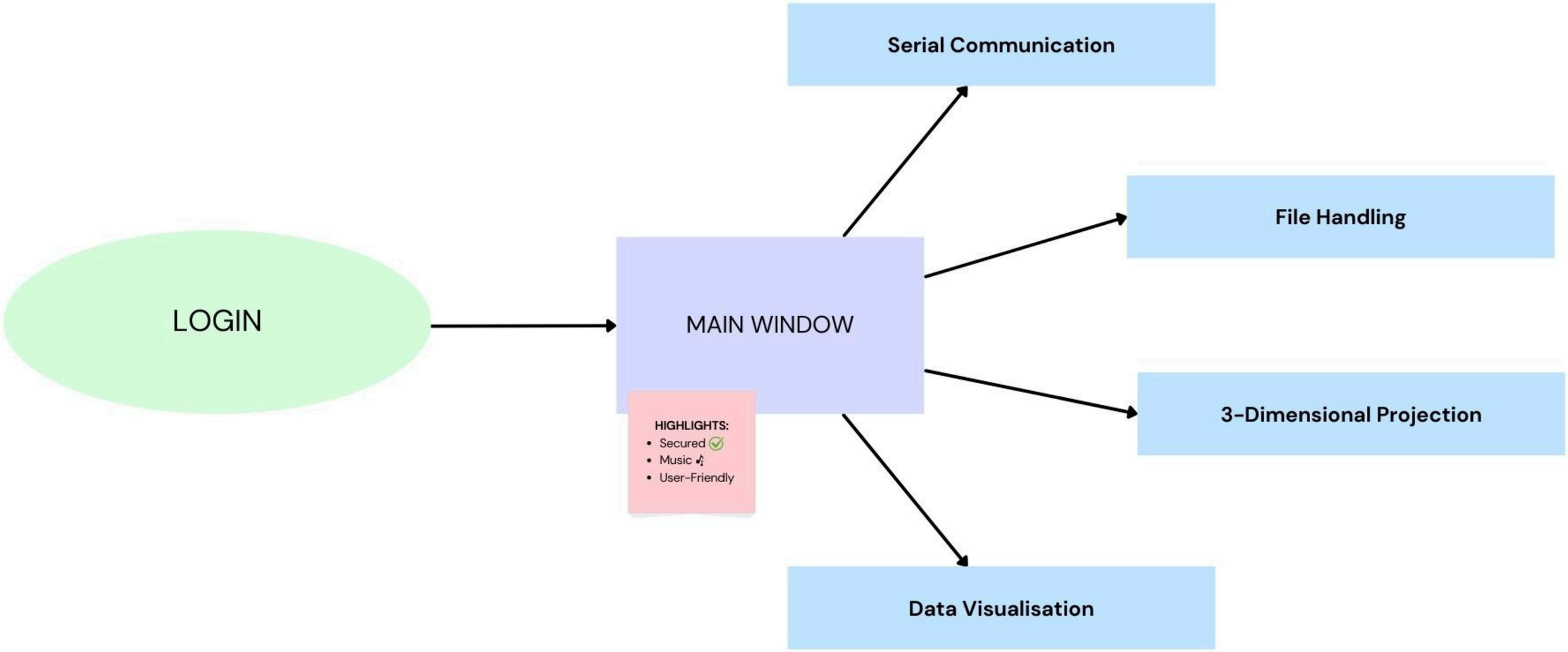


FILE HANDLING

3D -PROJECTION

DATA VISUALISATION

Flowchart


Serial Communication
File Handling
LOGIN
MAIN WINDOW
3-Dimensional Projection
HIGHLIGHTS:
Secured
Music
User-Friendly
Data Visualisation

End

THANK YOU