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Automated Engine Design using Machine Learning

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Abstract: ***Machine Learning has been widely used in solving complex problems across various fields for the past decade, and computers have become more powerful than ever before. Mechanical engineers have a responsibility to use these groundbreaking discoveries to improve existing instruments and methodologies for better efficiency in production. Technologies like Machine Learning, Deep Learning, and Computer Vision can automate complex design procedures and can be integrated with existing technologies to create the building blocks for the 5th industrial revolution. Computerized programs can be helpful in situations where resources like time and skilled labor are scarce. The project aims to use Machine Learning and other Python-based frameworks to develop an interactive interface for designing complex models, specifically a combustion engine.***

I. INTRODUCTION

"Automated Engine Design using Machine Learning" is our attempt to utilize groundbreaking discoveries in computer technology to make designing complex 3-dimensional objects easier and less time consuming. The core idea is to develop an advanced python script to design any Engine as per the load requirements with or without any direct specification of parameters. The idea also includes building a voice assistance technology interface using Machine Learning models for voice recognition and Machine-human interaction. In short, it's an end-to-end program which automates the process of design of an engine. The core task is to make a voice recognition program which takes a voice input (which may or may not explicitly specify any dimensions of design related to the engine) and return a designed CAD model of the same in ".stl", ". step" or ".amf" format as per the choice or requirement. The project can be divided into two separate blocks according to the function: Front end and Back end. Front end: ML algorithm that predicts design specifications analyzing the voice input Back end: Algorithm that produces the 3D CAD model according to the specifications received from the Front end and returns the produced file in the required format of choice

II. OBJECTIVES

1) To solve complex design tasks & perform complex design procedures with the help of a computer
2) To develop a virtual assistive interface technology for Machine-human interaction
3) Use voice recognition for designing 3D objects
4) Develop a program that uses voice recognition to capture the requirements for a single/multiple cylinder petrol/diesel engine, analyzes the input, predicts the dimensions of the engine, & returns a 3D CAD model of the same in the required format of choice

III. METHODOLOGY OF PROJECT

The entire program can be divided into two parts: Front end: ML algorithm that predicts design specifications analyzing the voice input Back end: Algorithm that produces the 3D CAD model according to the specifications received from the Front end and returns the produced file in the required format of choice Following is a basic overview of the structure of the program:

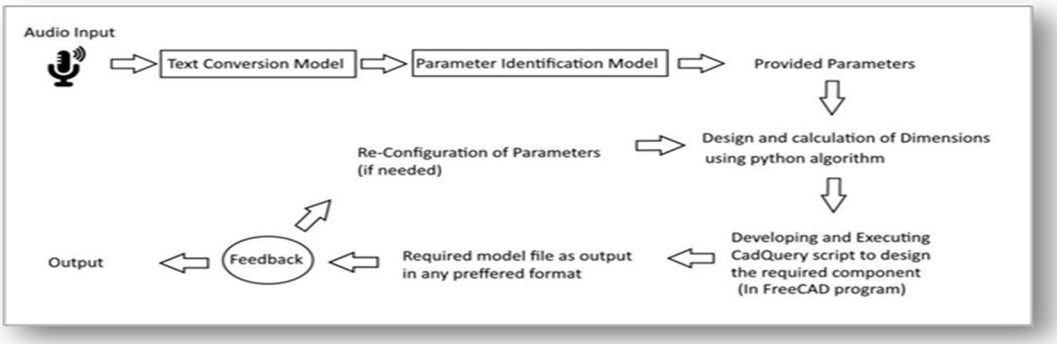


Figure 4.1Basic overall architecture of the project

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The upper flowchart explains the project's process for "Automated Engine Design using Machine Learning" with audio input as the main function. Users can manually enter values or use voice input, facilitated by the Vosk open-source speech recognition toolkit. Parameters are identified using pyttsx3, a Python library for text-to-speech conversion and calculated using pre-trained engine parameter code. If the design fails, users can provide new inputs. The parameters identification model identifies relevant parameters and executes the required procedures, with output customizable using pyttsx3's support for various voices, languages, and adjustable parameters such as volume, pitch, and speed.

The flowchart Figure 4.2 outlines the path from audio input to engine model design. The audio command is received through voice recognition technology, and then converted into text format using a speech-to-text model. The user inputs appropriate values for engine design parameters, with the interface suggesting the most efficient values. The engine design process begins, using the "Machine Design Data Book" for reference values. Theoretical engine design is achieved, and the interface displays it with reference page numbers for the user's understanding. The design can be saved as a PDF, and a 3D model is created using CAD Query Script. The user can then save the CAD model in the ".step" format to complete the process.

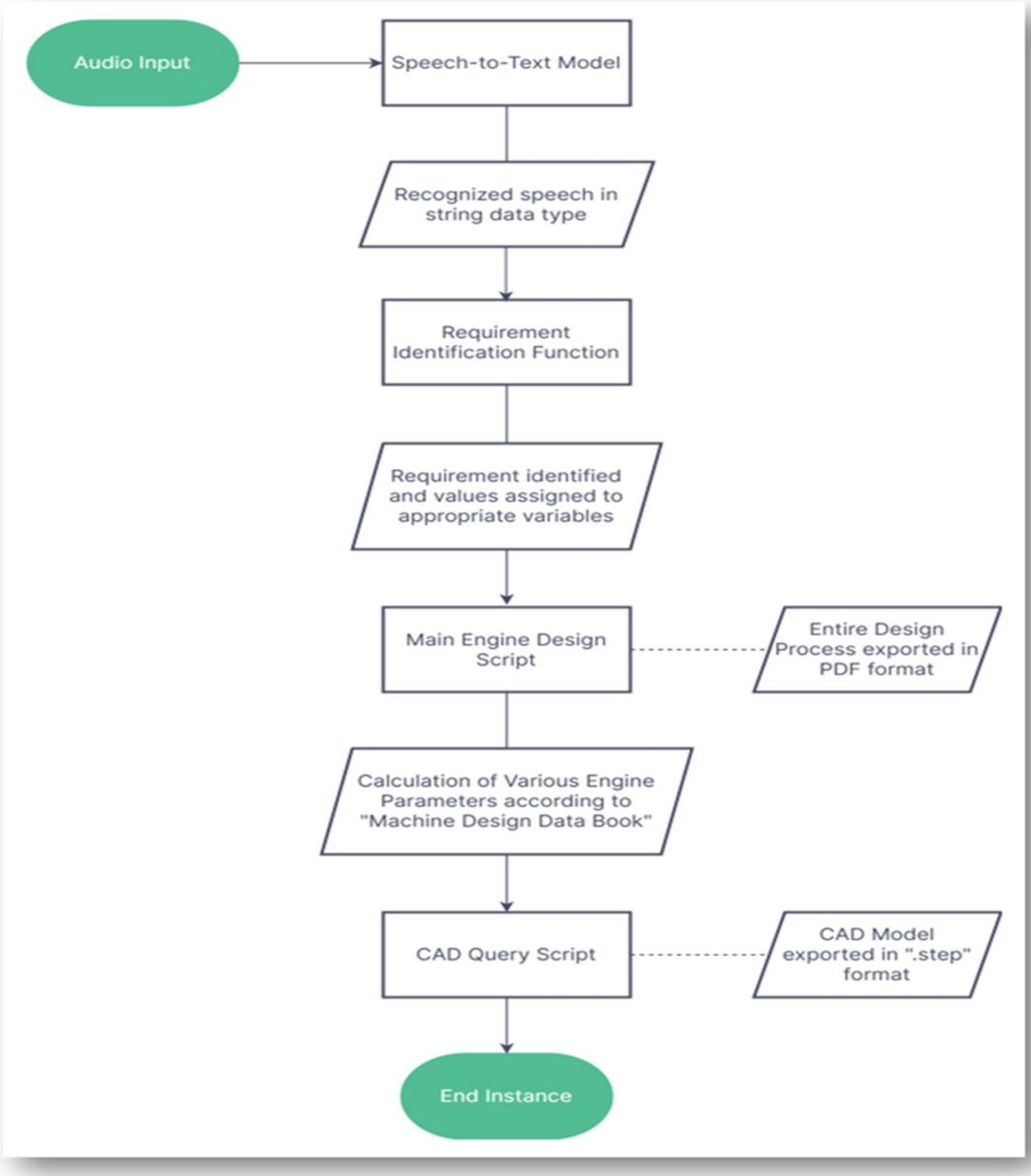


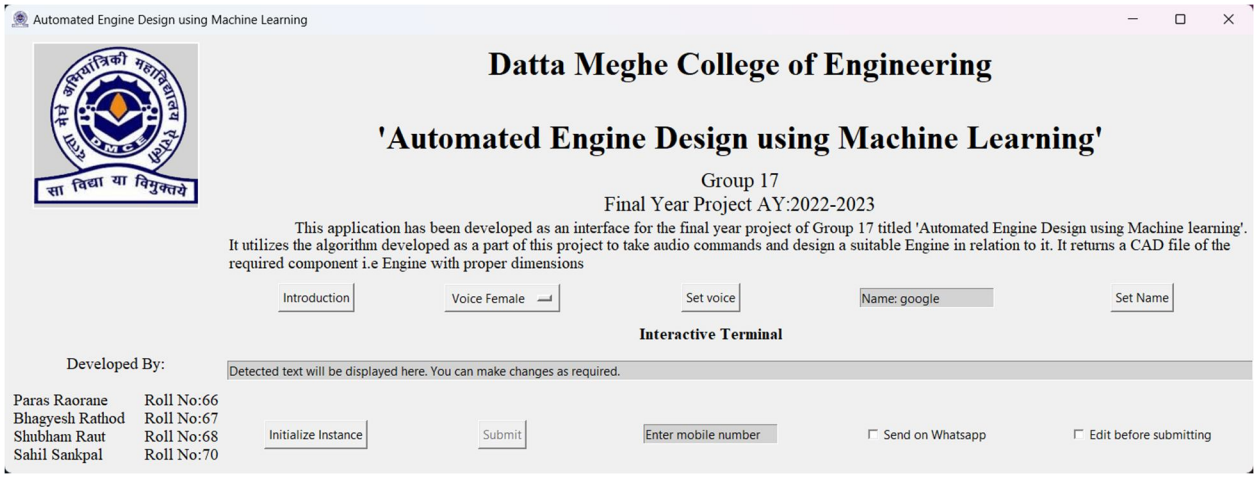
Figure 4.2 Detailed Architecture and Flow of Information

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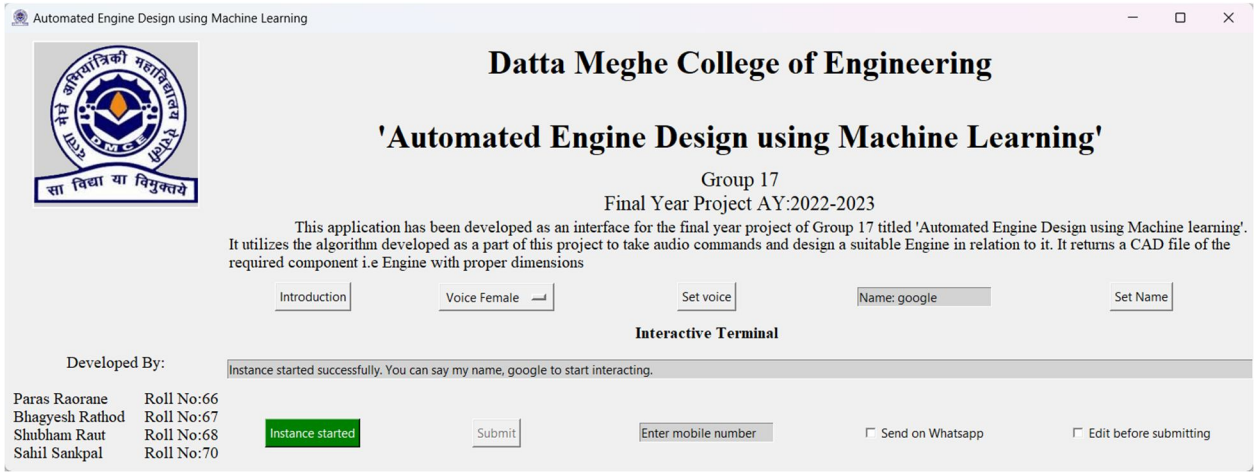
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IV. DESIGN AND EXPERIMENTAL SETUP

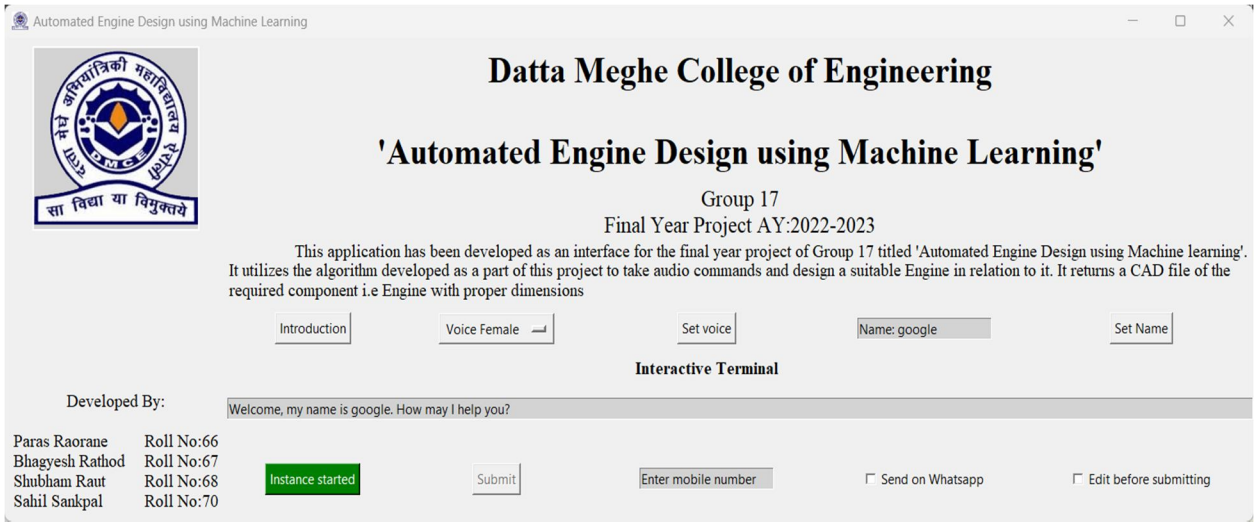
The following is the initial setup for the interface of the project. It consists of labels, description, convenience buttons, interactive terminal, and instance start/stop button.



After initiating instance

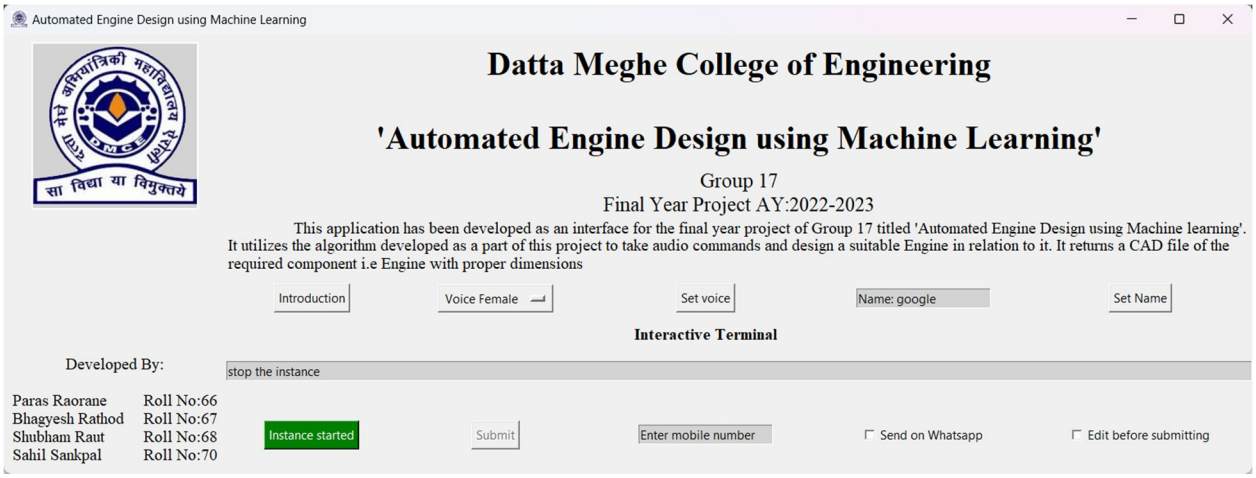


Calling the model by mentioning its name in the voice command. Response by the interface

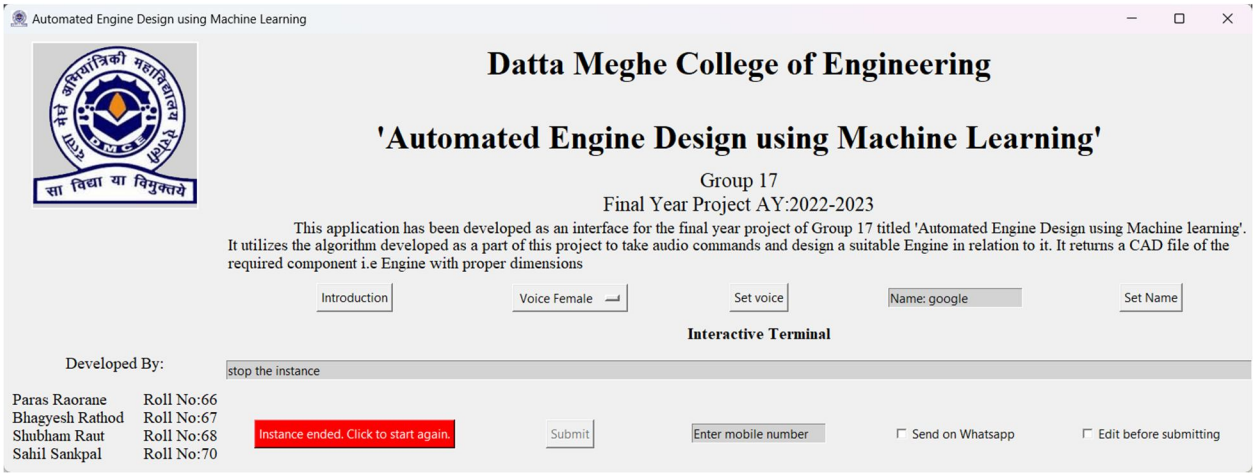


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Asking to stop the instance



Instance ended successfully



V. ANALYSIS OF DESIGN PROCEDURE

A. Relation between Brake-Power and Pressure Stress on Piston

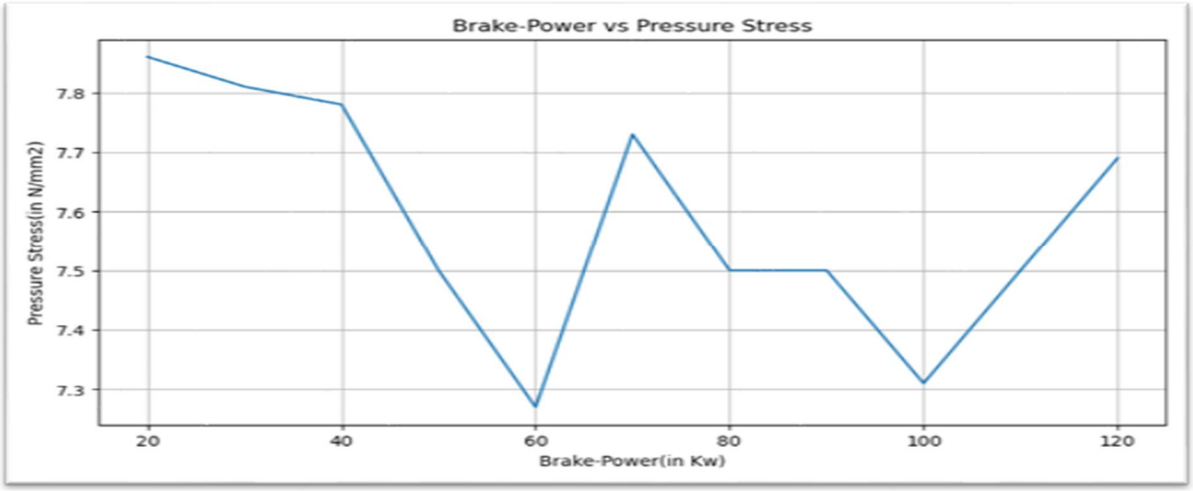


Figure 6.1 Brake-Power vs Pressure Stress on Piston

B. Relation between Engine Operating Speed and Pressure Stress on Piston

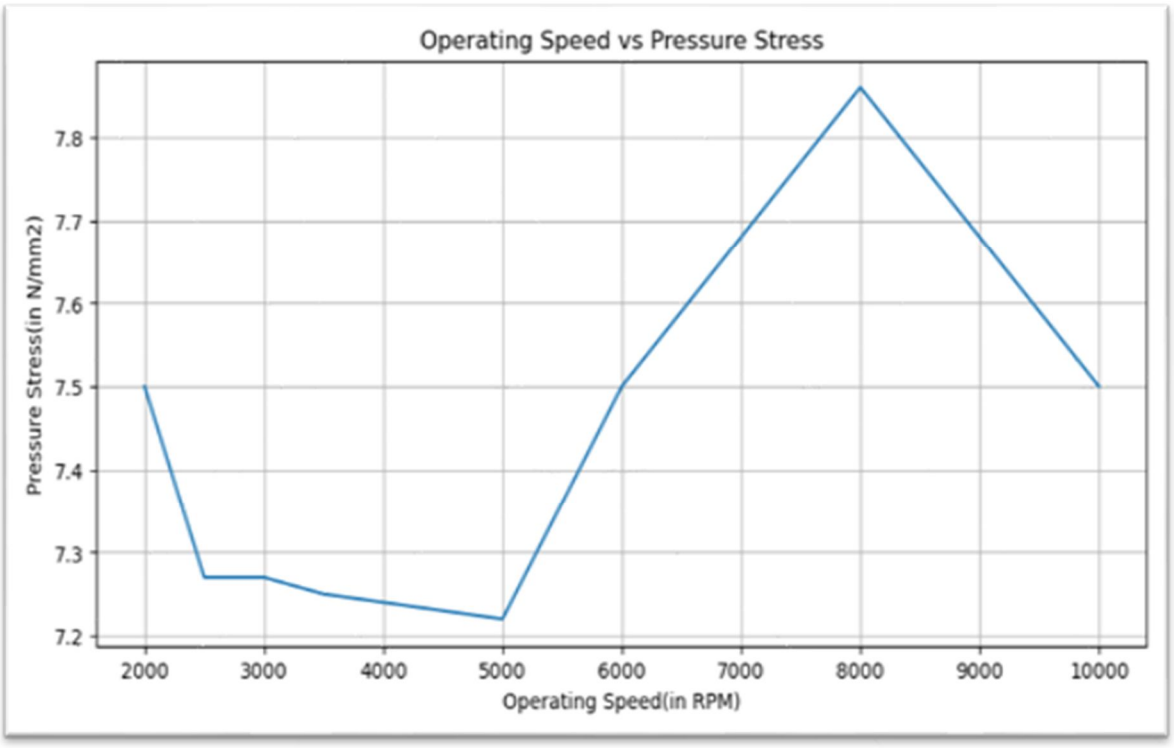


Figure 6.2 Operating Speed vs Pressure Stress on Piston

C. Relation between Air-Fuel Compression Ratio and Pressure Stress on Piston

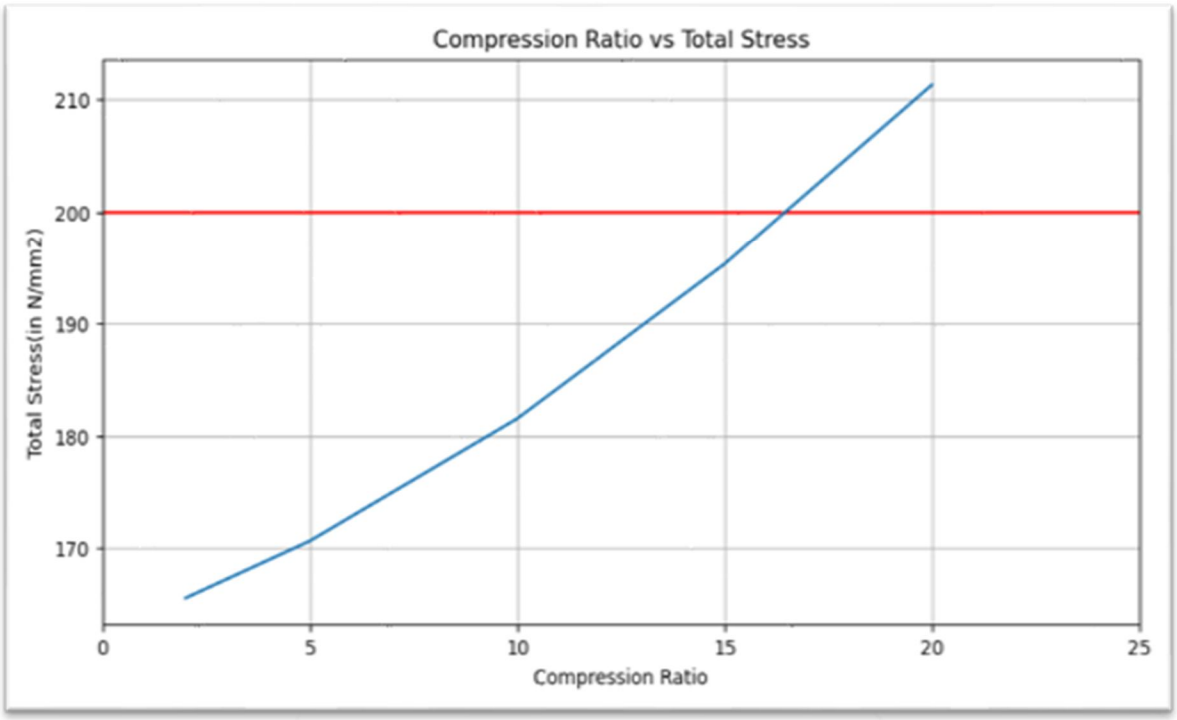


Figure 6.3 Compression Ratio vs Pressure Stress on Piston

D. Relation between Operating speed of Engine, Air-Fuel Compression Ratio and Pressure Stress on Piston

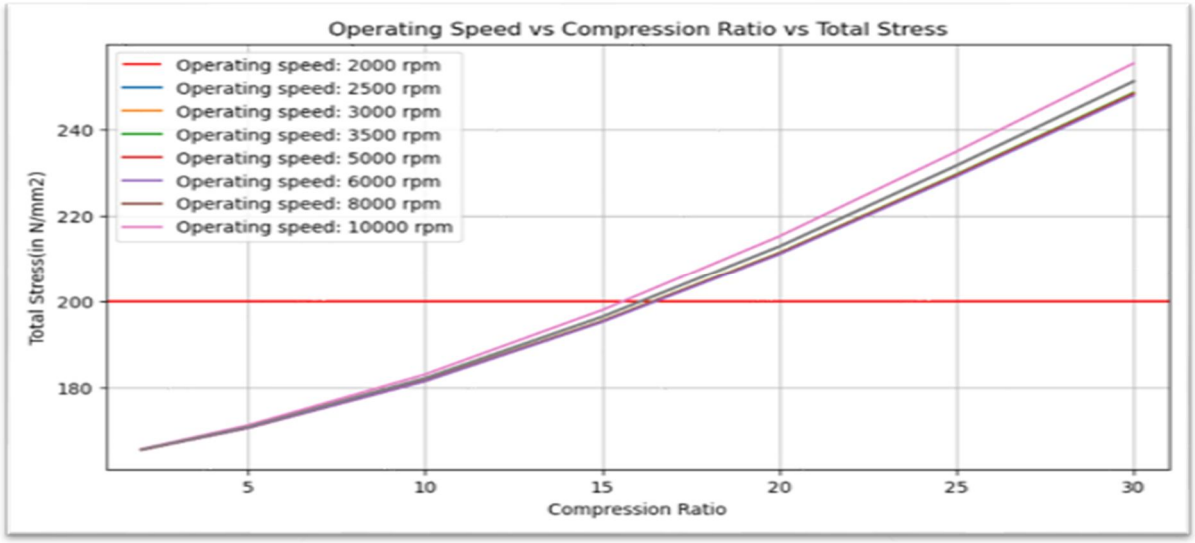


Figure 6.4 Operating Speed vs Compression Ratio vs Pressure Stress on Piston

E. Relation between Brake Power of Engine, Air-Fuel Compression Ratio and Pressure Stress on Piston

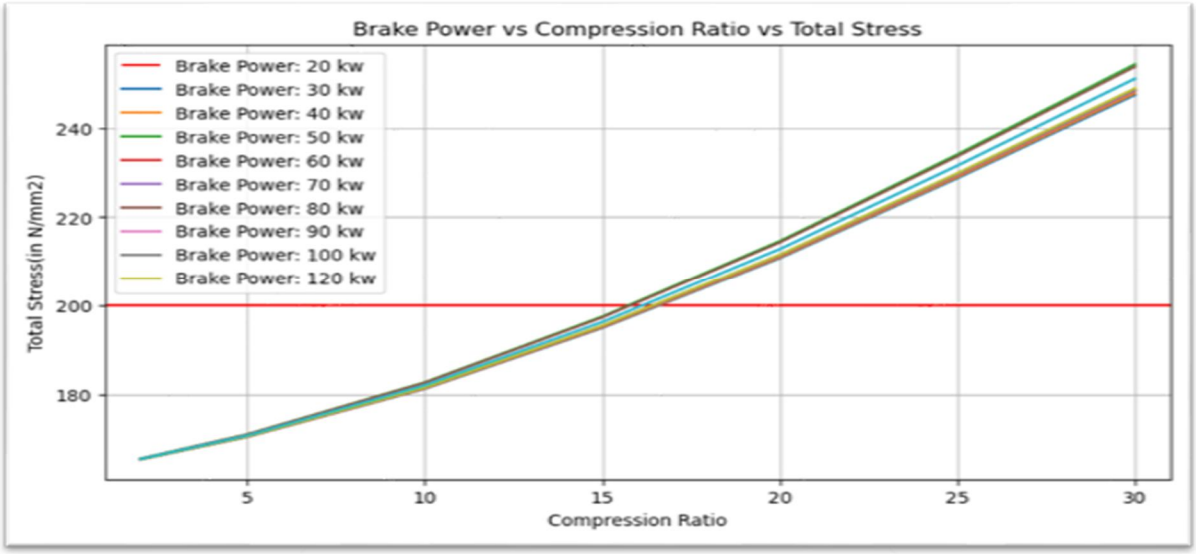


Figure 6.5 Brake Power vs Compression Ratio vs Pressure Stress on Piston

VI. CONCLUSION & FUTURE SCOPE

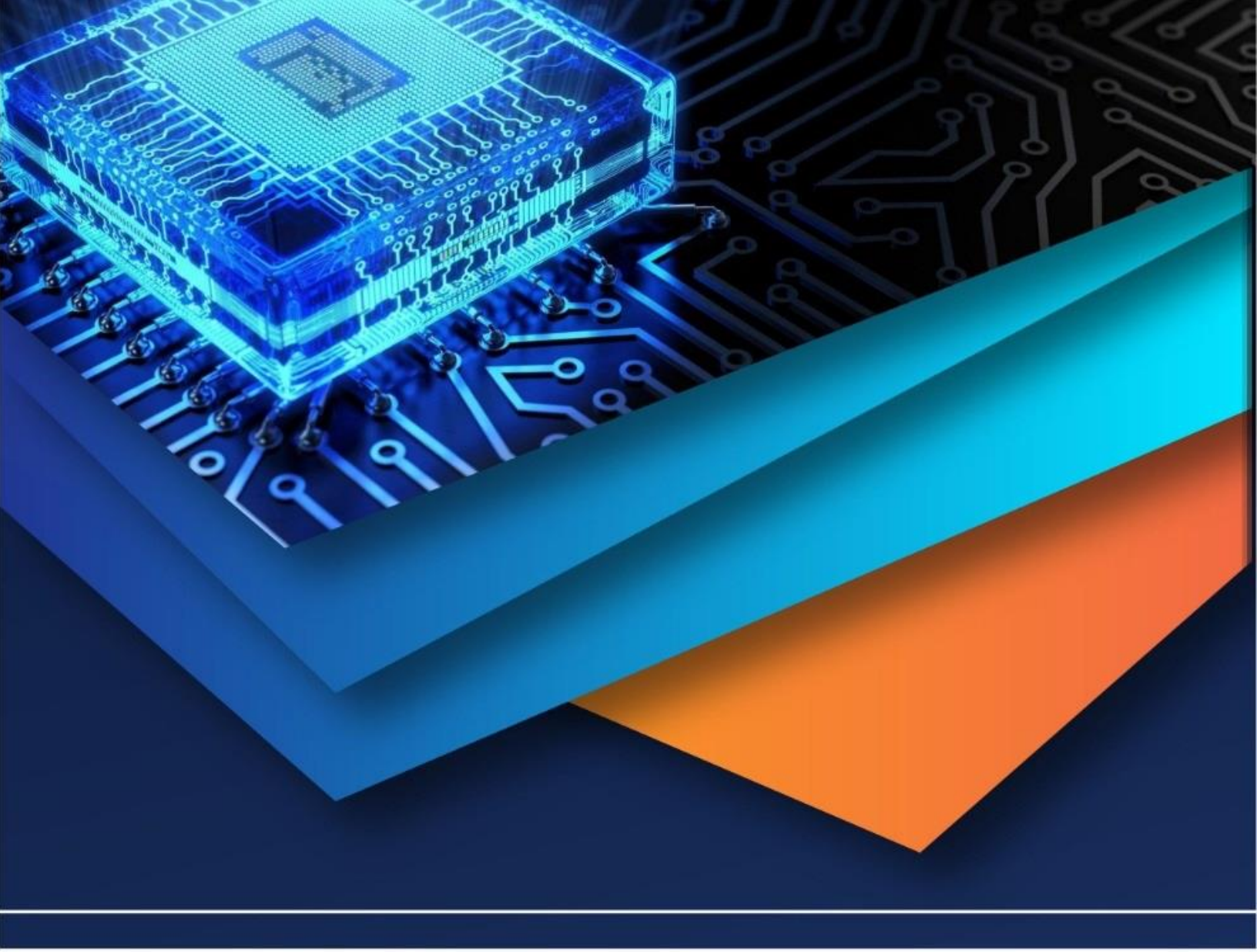
The project demonstrates the capability of Python to automate design procedures, making the overall process more efficient and effective. The use of Python in automating design tasks has several benefits, including increased accuracy, faster processing times, and reduced human error. The project showcases the successful usage of Python in automating design procedures and tasks, highlighting the benefits of using Python in the design process. Virtual assistive interface technology represents a major step forward in the field of automation. It bridges the gap between humans and machines, making it easier for designers and engineers to interact with complex systems and machines. The potential applications of this technology extend far beyond engineering, including healthcare and transportation industries, improving safety and efficiency. In conclusion, computer-aided design tools are crucial for solving complex design tasks and procedures, and the development of virtual assistive interface technology has the potential to improve efficiency, reduce errors, and enhance safety across a wide range of industries.

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VII. FUTURE SCOPE

The project presented highlights the potential of Python in automating design tasks and procedures, offering several benefits such as increased accuracy, faster processing times, and reduced human error. There are still several avenues for future research and development in this area. One future scope is the exploration of different machine learning algorithms that can be applied to automate design procedures. Python's machine learning libraries, such as Scikit-learn and TensorFlow, can be leveraged to create models that can learn from previous design data and generate design solutions based on specific requirements. Another area of future research is the integration of Python with other design software and tools. By seamlessly integrating Python scripts with other design software, engineers and designers can streamline their workflow and automate repetitive tasks. Furthermore, the development of virtual assistive interface technology presents a significant opportunity for future research and development. By enhancing the interaction between humans and machines, this technology can enable engineers and designers to collaborate more effectively with machines, potentially improving safety and efficiency across various industries. In conclusion, the application of Python in automating design tasks and procedures has several benefits, and there are several opportunities for future research and development in this area. Additionally, the development of virtual assistive interface technology has the potential to revolutionize how engineers and designers interact with complex systems, and improve safety and efficiency across various industries.

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