

Software Configuration Steps

1.1 Functional and Non-functional requirements

Requirements analysis is very critical process that enables the success of a system or software project to be assessed. Requirements are generally split into two types: Functional and non- functional requirements.

Functional Requirements: The proposed predictive maintenance system must efficiently analyze real-time sensor data from aircraft components to predict failures before they occur. It should integrate machine learning models, such as Random Forest, to ensure accurate fault detection and decision-making. The system should provide an interactive dashboard for maintenance personnel to visualize alerts, analyze predictive insights, and take necessary actions. The following functional requirements are essential for the system:

- **Data Acquisition & Processing** – The system should collect real-time data (e.g., vibration, temperature, pressure) from IoT sensors and preprocess it by handling missing values, noise reduction, and feature extraction.
- **Machine Learning Model Training & Prediction** – The system should implement advanced machine learning algorithms for predictive analytics, ensuring high accuracy in fault detection.
- **User Authentication & Role-Based Access** – The system should support secure login for different user roles:
- **Maintenance Engineers** – View predictive maintenance reports, receive alerts, and schedule maintenance.
- **Administrators** – Manage system configurations, monitor overall performance, and ensure data security.
- **Predictive Insights & Alert System** – The system should generate real-time maintenance alerts when anomalies or potential failures are detected.

- **Model Performance Monitoring** – Use MLflow to track, evaluate, and update the predictive maintenance models based on changing operational conditions.
- **Integration with Existing Systems** – Ensure compatibility with existing aircraft maintenance and enterprise resource planning (ERP) systems for seamless workflow integration.
- **Logging & Reporting** – Maintain detailed logs of all predictive analytics, including model predictions, maintenance actions taken, and system performance metrics.

Non-functional requirements: The system must ensure high performance, scalability, security, reliability, and usability to support seamless deployment in aircraft maintenance operations. It should be capable of processing vast amounts of sensor data efficiently, ensuring low latency in prediction results. Scalability is essential to accommodate increasing data loads and additional aircraft without compromising performance. Security measures must be in place, including data encryption, access controls, and authentication mechanisms, to prevent unauthorized access to sensitive maintenance data. High availability is a key requirement, ensuring uninterrupted operation with minimal downtime, supported by fault-tolerant infrastructure and backup recovery mechanisms. The system should also be user-friendly, offering an intuitive interface for maintenance personnel to interact with predictive insights effectively. Additionally, reliability is critical, ensuring accurate predictions with continuous learning and model updates to adapt to evolving operational conditions. The predictive maintenance system must also integrate seamlessly with existing IT infrastructure while maintaining efficiency in computational power and resource utilization.

1. Performance

- The system should process large volumes of sensor data efficiently with minimal latency.
- Machine learning models must provide predictions in real-time or near real-time.

2. Scalability

- The architecture must support increasing sensor data loads and additional aircraft without performance degradation.
- Can be scaled vertically (better hardware) or horizontally (distributed cloud-based deployment).

3. Security

- The system must protect sensitive aircraft data using encryption and secure access controls.
- Implement role-based authentication to prevent unauthorized access to predictive maintenance insights.

4. Availability

- Ensure 99.99% uptime to allow uninterrupted monitoring and prediction of potential failures.
- Must handle system failures with fault-tolerant mechanisms and backup recovery.

5. Usability

- The dashboard and reports should be user-friendly, requiring minimal training for maintenance personnel.
- Maintenance alerts should be easy to interpret and act upon.

6. Reliability & Fault Tolerance

- The system should function seamlessly even during partial failures, with redundant data storage and failover mechanisms.
- Predictive models should be continuously retrained to adapt to new operational patterns.

2.1 Hardware Requirements

Processor	- I3/Intel Processor
Hard Disk	- 160GB
Key Board	- Standard Windows Keyboard
Mouse	- Two or Three Button Mouse
Monitor	- SVGA
RAM	- 8GB

3.1 Software Requirements

Operating System	: Windows 7/8/10
Programming Language	: Python
Libraries	: Pandas, Numpy, Joblib, Streamlit, Random, Time
IDE/Workbench	: VS Code
Technology	: Python 3.8

4.1 Installation of Python

Python has become one of the most popular programming languages of the 21st century. It is being used for multiple purposes in various sectors of business. Developers use Python for building applications and developing websites. Data Engineers use python for performing data

analysis, statistical analysis, and building machine learning models. However, you can check if it exists on the system by running one line of command on the command prompt: `python-- version`.

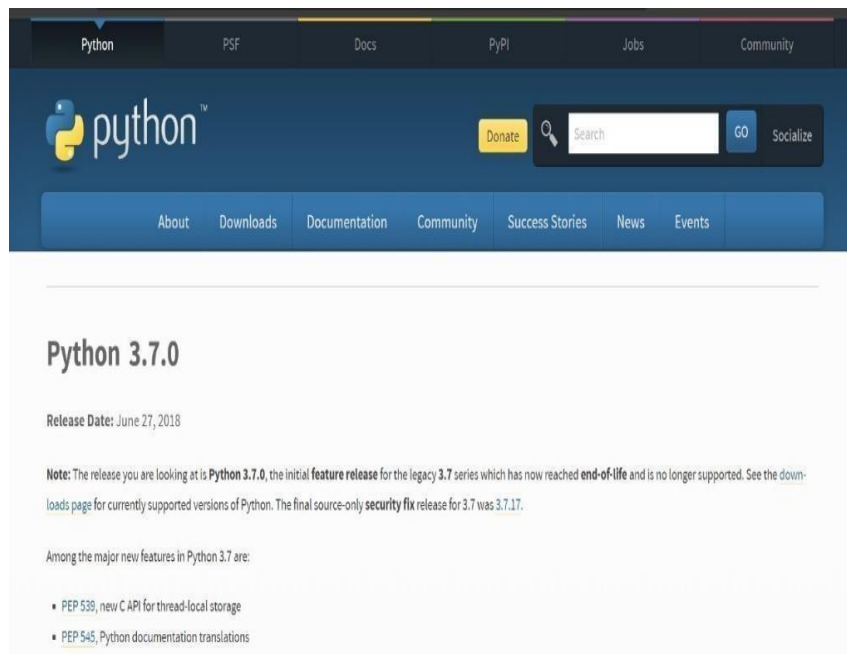


Fig. No. 4.1: Python download website

To download python, open the chrome and browse by typing python download. Download “python 3.7.0” version from the internet because it is compatable with our project.

Full Changelog

Files

Version	Operating System	Description	MD5 Sum	File Size	GPG
Gzipped source tarball	Source release		41b6595deb4147a1ed517a7d9a580271	21.7 MB	SIG
XZ compressed source tarball	Source release		eb0c2a5b1447d50813c02714ef4601f3	16.1 MB	SIG
macOS 64-bit installer	macOS	for OS X 10.9 and later	ae0717a02efa3b0eb34aad680dc498	26.4 MB	SIG
macOS 64-bit/32-bit installer	macOS	for Mac OS X 10.6 and later	ca3eb84092d07ff6d02e42f63a734338e	32.7 MB	SIG
Windows help file	Windows		46562af86c2049dd0cc7680348180dca	8.2 MB	SIG
Windows x86 embeddable zip file	Windows		ed9a1c028c1e99f5323b9c20723d7def	6.1 MB	SIG
Windows x86 executable installer	Windows		ebb644c284c1447e902e87381afeff0	24.3 MB	SIG
Windows x86 web-based installer	Windows		779c4085464eb3ee5b1a4fffd0eabca4	1.2 MB	SIG
Windows x86-64 embeddable zip file	Windows	for AMD64/EM64T/x64	cb8b4f0d979a36258f73ed541def10a5	6.6 MB	SIG
Windows x86-64 executable installer	Windows	for AMD64/EM64T/x64	531c3fc821ce0a4107b6d2c6a129be3e	25.0 MB	SIG
Windows x86-64 web-based installer	Windows	for AMD64/EM64T/x64	3cfdaf4c8d3b0475aaec12ba402d04d2	1.3 MB	SIG

<https://www.python.org/ftp/python/3.7.0/python-3.7.0-amd64.exe>

Fig. No. 4.2: Python executable install

Select the “Windows x36-64 executable installer”.

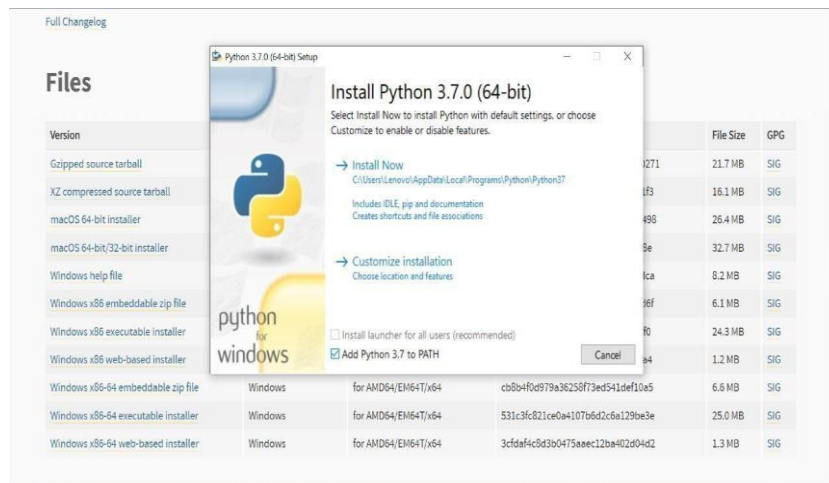


Fig. No. 4.3: Python path addition

Upon selecting the suitable version, a dialogue box pops up showing the options “Install now” and “Customize Installation”. Select the “Customize Installation” and check the “Add Python 3.7 to PATH”.

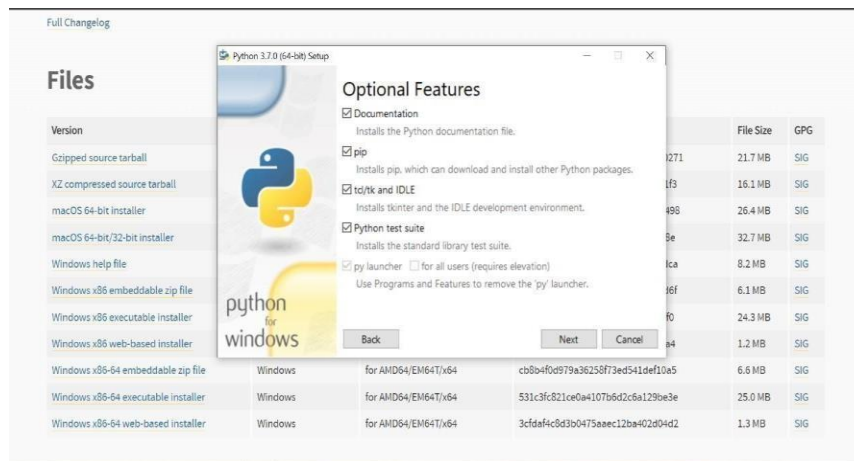


Fig. No. 4.4: Additional Feature

Adding all the additional features that are required for the execution of the code. Click on “Next” button after selecting the features. Another dialogue box names Advanced Options will be displayed. Check marks the box “Install for all Users”. We can also change the location where the python software to be installed. It is preferred to choose the default location option for installation. Click on “Install” button for successful installation of Python. Python software is installing all the executable files and libraries.

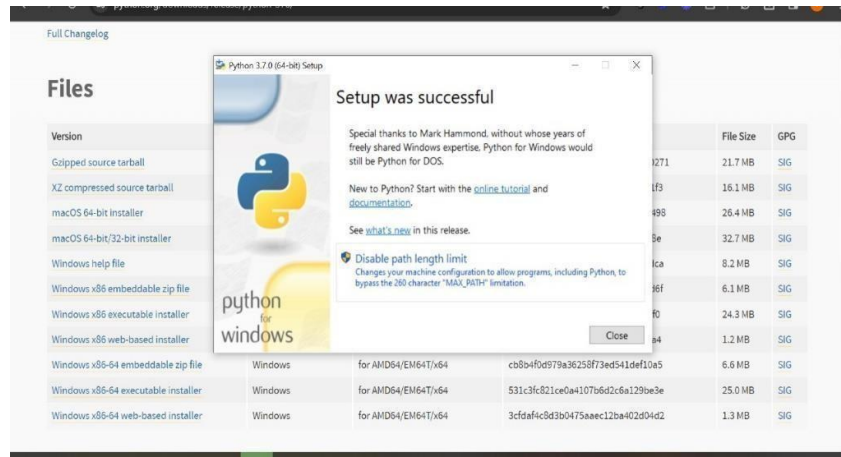


Fig. No. 4.5: Setup Successful

Python was successfully installed. Click on the “close” button to close the dialogue box.

5.1 Installation of Visual Studio

Visual Studio is an integrated development environment (IDE) developed by Microsoft. It provides comprehensive tools and features for software development across various platforms, including web, mobile, desktop, cloud, and more. Installing Visual Studio is essential for developers looking to leverage its powerful capabilities for writing, debugging, and deploying applications efficiently.

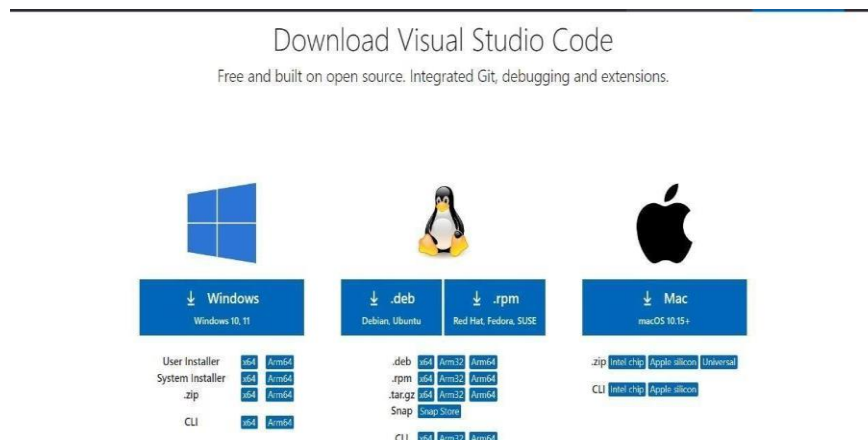


Fig. No. 4.6: Download Visual Studio

As Visual Studio is available for many Operating Systems, we have to select the type of the operating system that is supported by the Computer/Laptop.

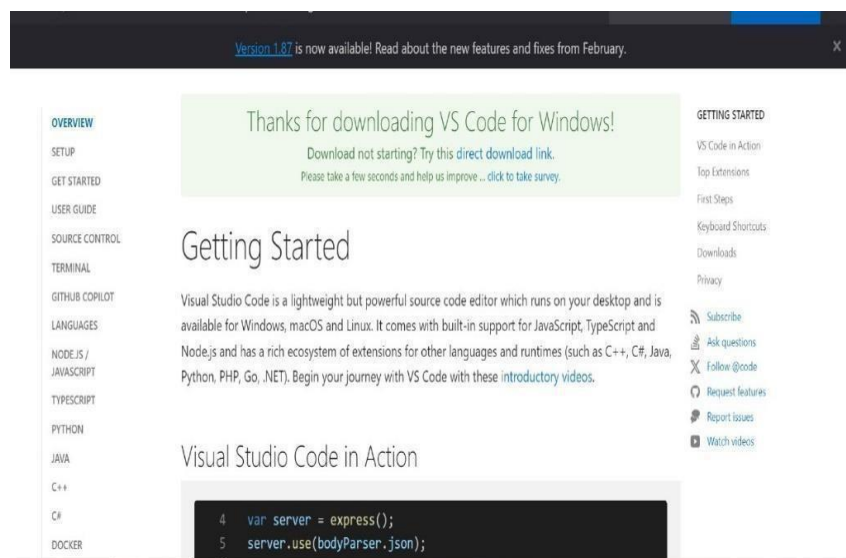


Fig. No. 4.7: Visual Studio Download

For setting up the Visual Studio Code, select the location to where it has to be installed. We can change the location by clicking on “Browse” button. Click on the “Next” button after selecting the location. Selecting all the additional features that are required for the successful installation of the visual studio code and click on “Next”. A Dialogue is

shown displaying the Destination Location, Menu Folder and Additional Tools for the confirmation. Proceed by clicking on the “Install” button to install Visual Studio Code.

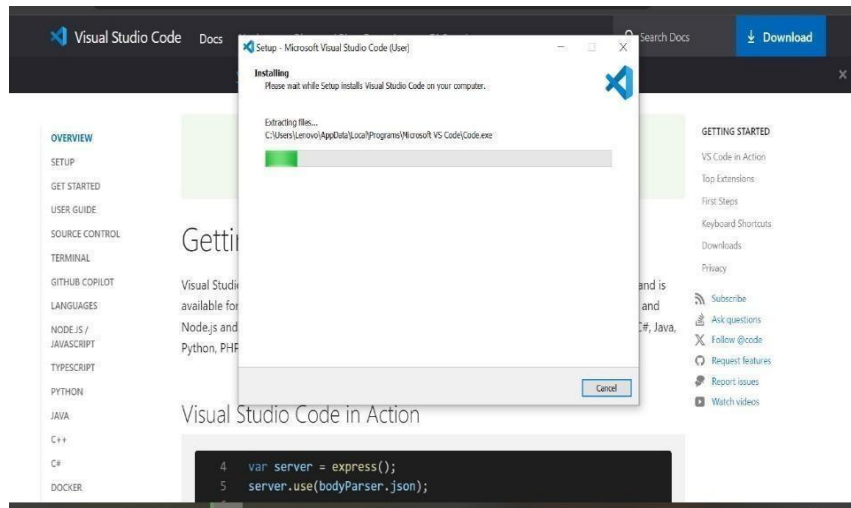


Fig. No. 4.8: Installing Visual Studio Code

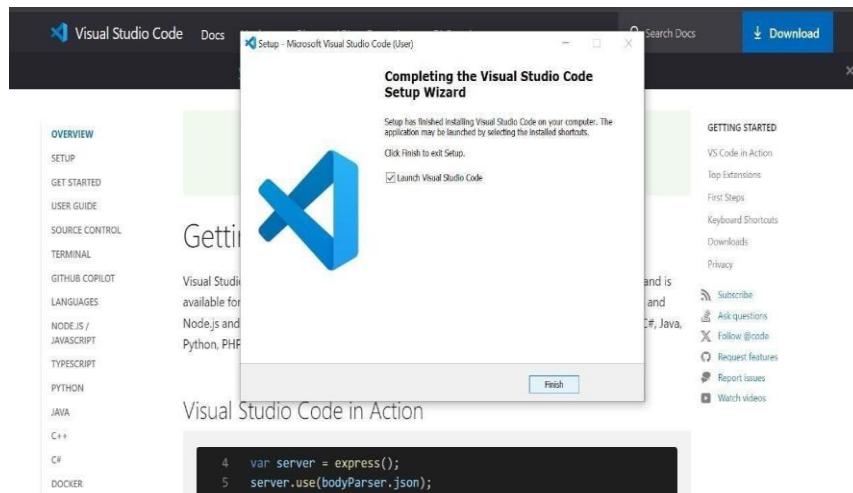


Fig. No. 4.9: Installation Completed

Visual Studio Code is installed.