**"Smart Condition Monitoring for Electric Motors using Data Analytics"**

**📌 Project Description:**

Develop a system that simulates (or collects real) sensor data from electric motors (e.g., temperature, vibration, current), processes the data using Python libraries like **NumPy, Pandas, Matplotlib**, and builds an **ML model using Scikit-learn** to predict motor failure or overheating conditions.

This mimics a real-time **motor condition monitoring system** used in **automotive**, **semiconductor fabs**, and **industrial plants**.

**🎯 Project Objectives:**

* Simulate embedded system data (or use offline sensor logs)
* Analyze time-series signals using NumPy & Pandas
* Visualize motor health trends using Matplotlib
* Use Scikit-learn to classify healthy vs faulty behavior
* Trigger alerts based on fault probability (optionally connect to Power Automate)

**🧠 Real-World Usage:**

| **Industry** | **Real Use Case Example** |
| --- | --- |
| Automotive | Electric vehicle motor monitoring (e.g., Continental, Bosch) |
| Industrial IoT | Predictive maintenance in factories (e.g., Siemens, GE) |
| Semiconductors | Wafer handling robot/motor diagnostics (e.g., Applied Materials) |
| Railways | Track train wheel vibration and temperature |

**🛠️ Tech Stack:**

| **Purpose** | **Tools / Libraries** |
| --- | --- |
| Data Simulation | Python + NumPy |
| Data Processing | Pandas |
| Visualization | Matplotlib, Seaborn |
| Machine Learning | Scikit-learn (Random Forest, SVM) |
| Notebook Environment | Anaconda + Jupyter Notebook |
| Automation (Optional) | Power Automate + Copilot Studio |

**🧩 Key Features:**

1. **Sensor Simulation or Data Import**
   * Parameters: motor\_temp, motor\_vibration, motor\_current, RPM
   * Simulate faults like sudden temp rise or irregular vibration
2. **Data Analysis**
   * Use Pandas to clean and aggregate
   * NumPy for rolling averages, FFT (frequency analysis for vibration)
3. **Visualization with Matplotlib**
   * Time-series plot: Temperature vs Time
   * Heatmap of current fluctuations
   * Scatter plot: Vibration vs RPM
4. **Machine Learning with Scikit-learn**
   * Train a classifier to predict motor fault status
   * Label: Healthy (0), Warning (1), Faulty (2)
   * Models: RandomForest, SVM, or Decision Tree
5. **Result Output**
   * Store predictions to CSV for Power BI
   * Optional: Use Excel triggers in Power Automate to send alerts

**📊 Example Visualizations:**

* 🔵 Line Chart: Temp over time
* 🟠 FFT Spectrum for vibration frequency
* 🟢 Scatter Plot: RPM vs Vibration
* 🟣 Confusion Matrix for classifier

**📁 Suggested Folder Structure:**

kotlin

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motor-condition-monitoring/

├── data/

│ └── motor\_simulated\_data.csv

├── notebooks/

│ └── motor\_analysis.ipynb

│ └── fault\_prediction\_model.ipynb

├── visualizations/

│ └── plots/

├── models/

│ └── trained\_model.pkl

├── README.md

**🧪 Sample User Stories (for Agile):**

| **ID** | **User Story** |
| --- | --- |
| US1 | As a technician, I want to view motor temperature over time to identify overheating. |
| US2 | As a reliability engineer, I want to receive alerts if fault probability > 80%. |
| US3 | As a data scientist, I want to train a classifier to detect early signs of motor failure. |

**✅ Skills Demonstrated:**

* Embedded systems context
* Signal processing + sensor analytics
* Time-series data processing
* Visualization and fault classification
* ML model building with Scikit-learn