**Problem Statement**

Cheetah and Chetak helicopters frequently experience Main Rotor Vibrations (MRV) and Tail Rotor Vibrations (TRV), requiring precise weight balancing to mitigate these issues. The current manual method for selecting appropriate weights is time-consuming and inefficient, involving:

* Measuring vibration limits at various flight conditions.
* Using Vibrex equipment to determine the required weight combination.
* Manually selecting weights within predefined ranges:
  + Tail Rotor: 80g to 104g (24g range).
  + Main Rotor: 26g to 360g (336g range).
* Each correction takes 2-3 minutes, leading to:
  + Increased aircraft operation time.
  + Higher fuel consumption.
  + Unnecessary component wear.

With 192 helicopters in the Army Aviation fleet requiring 4-5 corrections per year, and each correction involving 3-4 readings, the operational cost impact is substantial.

**Solution**

To address this inefficiency, a **Web-Based/Mobile Application** will be developed to automate weight selection for MRV and TRV, reducing correction time from minutes to seconds. This solution will result in:

* **Faster weight selection** - instant calculation (1 second) instead of manual trial-and-error.
* **Reduced aircraft operating time** - eliminating unnecessary operations.
* **Lower fuel consumption** - minimizing aircraft runtime.
* **Increased component lifespan** - reducing wear due to excessive corrections.

**How This Application Will Save Time**

| **Factor** | **Current Process** | **With Application** | **Annual Savings** |
| --- | --- | --- | --- |
| Time per correction | 2-3 minutes | 1 second | 90 minutes per year per helicopter |
| Total corrections per year (192 helicopters) | 5 each | 5 each | 17,280 minutes (~288 hours saved per year fleet-wide) |
| Fuel and cost savings | High due to extra operating time | Reduced significantly | Major savings in costs and component wear |

**Vibration Weight Calculator Overview**

The **Vibration Weight Calculator** is a web-based application designed to help users find the closest possible combinations of two weights that sum up to a required target weight within a specified tolerance. It is particularly useful in fields requiring precise weight balancing, such as rotorcraft maintenance and manufacturing processes.

**Features and Requirements**

1. **User Interface**
   * **File Upload**: Users can upload an Excel file containing weights.
   * **Target Weight Input**: Users can input the required target weight.
   * **Show Weights Button**: Displays the current list of weights.
2. **Functionality**
   * **Excel File Processing**: The application will process an uploaded Excel file containing two columns: index (serial number) and weight in grams.
   * **Display Current Weights**: Users can view the current list of weights in a pop-up.
   * **Find Closest Weight Combinations**:
     + Displays up to 10 of the closest possible combinations of two weights summing up to the required target weight, within a tolerance of **±0.5 grams**.
     + Ensures each weight appears in results at most **3 times**.
     + Sorts results based on proximity to the required target weight.
3. **Output**
   * **Result Format**:
   * Index 1, Weight: 48.7 grams
   * Index 2, Weight: 51.3 grams
   * Total Weight: 100.00 grams (Difference: 0.00)
   * **Result Display**: Results will be shown in a pop-up format for easy viewing.

**Detailed Description**

1. **Uploading and Reading Excel File**
   * Users upload an Excel file with two columns: the first column contains the index or serial numbers, and the second column contains the corresponding weights in grams.
   * The application reads and processes the file to extract weight data.
2. **Displaying Current Weights**
   * Clicking the "Show Current Weights" button will display a pop-up list of weights with their indices.
3. **Finding Weight Combinations**
   * Users input a target weight.
   * The application calculates the closest combinations of two weights from the list that sum up to the target weight within a tolerance of **±0.5 grams**.
   * Ensures each weight appears at most **three times** in the result set.
   * Results are sorted based on proximity to the target weight.
4. **Displaying Results**
   * Results are displayed in a pop-up format.
   * Each combination includes the indices and weights of the two weights, total weight, and the difference from the target weight.

**Example Use Case**

**Uploaded Excel File Data:**

| **Index** | **Weight (grams)** |
| --- | --- |
| 1 | 48.7 |
| 2 | 51.3 |
| 3 | 49.5 |
| 4 | 50.2 |

**User Inputs a Target Weight of 100 grams:**

**Application Output:**

1, Weight: 48.7 grams

2, Weight: 51.3 grams

Total Weight: 100.00 grams (Difference: 0.00)

3, Weight: 49.5 grams

4, Weight: 50.2 grams

Total Weight: 99.7 grams (Difference: 0.30)

**Implementation Technologies**

* **Frontend**: HTML, CSS, JavaScript
* **Libraries**: XLSX.js for reading Excel files

**Conclusion**

The **Vibration Weight Calculator** is a practical tool designed to simplify the process of finding optimal weight combinations for precise balancing tasks. Its user-friendly interface and robust functionality make it a valuable resource for professionals in rotorcraft maintenance and other technical fields. By automating weight selection, the application significantly reduces correction time, operational costs, and component wear, making it a game-changer in helicopter maintenance efficiency.