**Preliminary Report: Smart Condition Monitoring System**

## 1. Introduction

This report provides an overview of the initial progress in the development of the Smart Condition Monitoring (SCM) system. The SCM system utilizes an ESP32 microcontroller, a GY-521 accelerometer, and a Noctua NF-P12 redux-1700 PWM fan to monitor and analyze vibration data for predictive maintenance. This preliminary report follows the proposed timeline, detailing system deployment progress and preliminary results. Additionally, a system diagram illustrating the fan and ESP assembly is included.

## 2. Sensor Selection and Challenges

Initially, the MPU-9250 sensor was considered for this project. However, several challenges arose, leading to its replacement with the GY-521:

- **Complexity of Data Processing**: The MPU-9250 is a nine-axis sensor, which would require extensive data processing beyond the project's scope and available timeline.
- **Sensor Malfunction**: The unit acquired for testing only provided temperature readings, while accelerometer and gyroscope functionalities were non-operational despite extensive testing on both the ESP32 and Arduino platforms.

Given these constraints, the GY-521 was selected due to its reliability and ease of integration. It features a three-axis accelerometer, which is sufficient for vibration analysis.

## 3. Sensor Assembly and Integration

- **Soldering Process**: The GY-521 required soldering for stable electrical connections. As a first-time experience in soldering, key lessons learned included:
    - Avoiding short circuits by carefully applying solder to prevent bridging between adjacent pins.
    - Ensuring robust mechanical and electrical connections to prevent detachment during operation.
- **Verification of Sensor Functionality**:
    - The GY-521 was connected to the ESP32 and tested using a simple script to confirm accelerometer data acquisition.
    - Orientation tests confirmed responsiveness, validating sensor integrity compared to the faulty MPU-9250.

**4. Fan Selection and Mounting Considerations** The selection of a suitable fan was critical for effective vibration monitoring. The Noctua NF-P12 redux-1700 PWM fan was chosen due to:

- **Sufficient Power and Speed**: At 1700 RPM, the fan generates noticeable vibrations, facilitating effective differentiation between operational states.
- **Robust Housing**: Provides a stable mounting base for the GY-521 and other components.
- **Adequate Surface Area**: Ensures a mini breadboard can be securely attached using adhesive backing.

**5. Sensor Placement and Optimization** For accurate vibration readings, the GY-521 was placed centrally on the fan's housing. This placement ensures:

- **Consistent Measurement**: Central mounting minimizes variance due to asymmetric vibrations.
- **Structural Stability**: The fan's housing offers a solid surface to prevent sensor displacement during operation.
- **Ease of Data Collection**: A stable sensor placement improves repeatability in vibration readings.

**6. Power Supply Considerations** The fan operates on a 12V power supply, which ensures reliable performance at maximum speed. A dedicated power source was selected to prevent power fluctuations that could affect sensor readings.

**7. Software Development** Software development has now commenced, focusing initially on establishing a reliable MQTT connection. Key aspects being implemented include:

- **Wi-Fi Initialization and Connectivity**: Ensuring the ESP32 can connect to a wireless network for data transmission.
- **MQTT Protocol Implementation**: Developing an MQTT client to publish and subscribe to sensor data topics.
- **Accelerometer Data Acquisition**: Implementing I2C communication with the GY-521 for real-time vibration data collection.
- **Filtering and Signal Processing**: Applying moving average filtering and root mean square (RMS) calculations to refine data.

- **Mode-Based Data Collection**: Differentiating between STOP, NORMAL, BLOCK, and ROTOR IMBALANCE modes based on vibration patterns.

The next steps include finalizing MQTT communication, collecting structured vibration data, and comparing results with existing datasets to improve predictive accuracy.

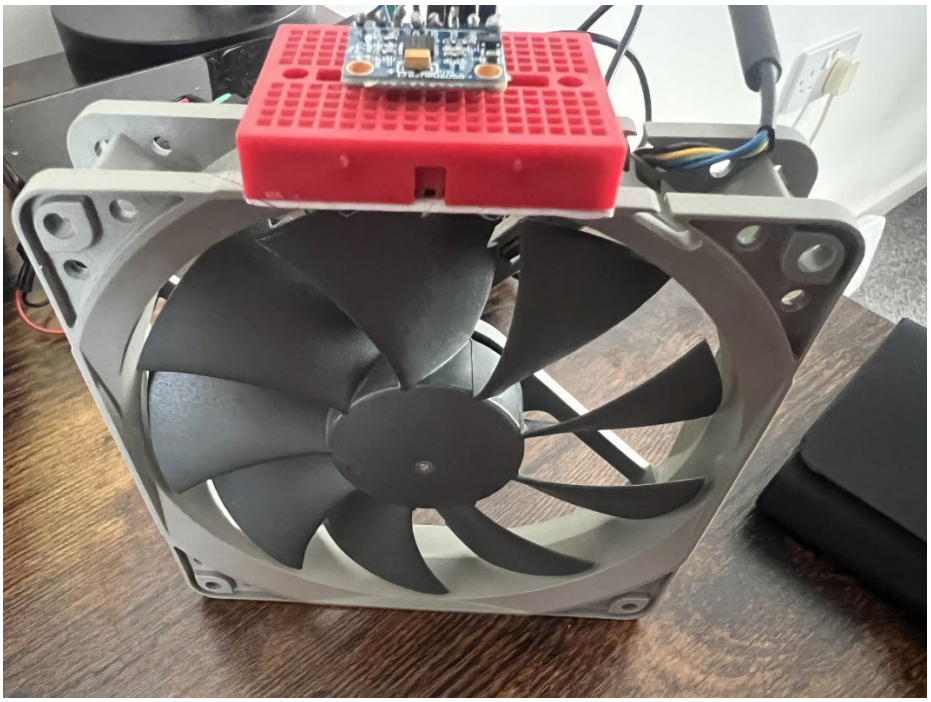
**8. Preliminary Results**

- Successful sensor integration and data acquisition confirm that the GY-521 is functioning as expected.
- The Noctua fan produces measurable vibration changes under different operating conditions, supporting future machine learning model development.
- Initial tests show clear distinctions in accelerometer data between stopped and running states.

**9. Next Steps**

- **Data Collection & Processing**: Gathering vibration data for different fan speeds to train the predictive maintenance model.
- **ESP32 Camera Integration**: Incorporating visual monitoring to complement vibration analysis.
- **Machine Learning Implementation**: Developing a classification model to predict motor conditions.
- **User Interface Development**: Creating a dashboard for real-time data visualization.

**10. Diagram: Fan and ESP Assembly**



**Summary of wiring**

| ESP32 Pin | GY-521 (MPU6050) Pin | Description |
|---|---|---|
| **3.3V** | VCC | Power Supply |
| **GND** | GND | Ground Connection |
| **GPIO21** | SDA | I2C Data Line |
| **GPIO22** | SCL | I2C Clock Line |

This preliminary phase has successfully validated core components, and the next steps will focus on refining data processing and implementing predictive algorithms. The project remains on track according to the proposed timeline.