

Motor Condition Monitoring System

Real-time Fault Detection using Vibration Analysis – 775 12 V DC Motor

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problem & motivation

- Motor failures cause costly downtime in industrial systems
- Early fault detection enables preventive maintenance
- Manual inspection is time consuming and unreliable
- Need for automated, realtime monitoring solution

what's my asset?



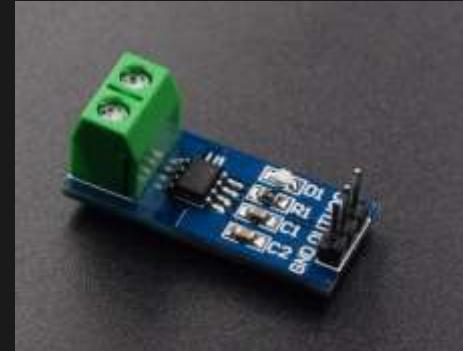
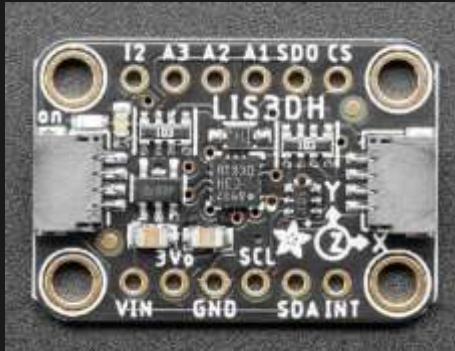
hardware & sensors

sensor suite

- **LIS3DH**: 3-axis accelerometer (+- 8g range, 400 Hz)
- **TCRT5000**: Optical tachometer for RPM
- **ACS712**: Current sensor

key features

- 400 Hz sampling rate (should satisfy Nyquist at 10k RPM)
- Burst-based data collection (400 samples/s)
- I2C communication error handling



system architecture

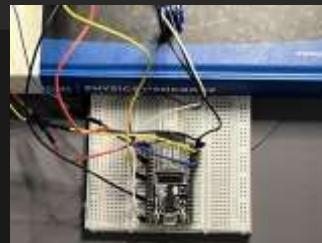
sensors

LIS3DH
Accelerometer
ACS712 Current
Sensor
TCRT5000 RPM
Sensor



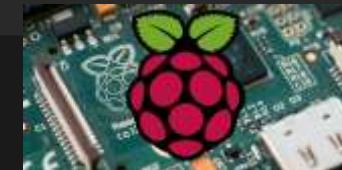
edge device

ESP32 (400 Hz
sampling) and
streams raw data to
RPi 5 for feature
extraction



gateway

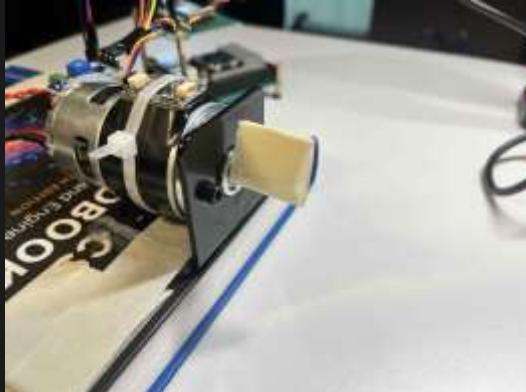
Raspberry Pi 5
MQTT publishing
Node-RED
dashboard



data collection & methods

fault conditions

- Baseline (healthy motor)
- Light imbalance
- Heavy imbalance
- Mounting looseness



- baseline_4_20251019_142529.csv
- baseline_5_20251019_142604.csv
- baseline_OFF_20251019_141701.csv
- imbalance_heavy_1_20251019_144237.csv
- imbalance_heavy_2_20251019_144302.csv
- imbalance_heavy_3_20251019_144326.csv
- imbalance_heavy_4_20251019_144351.csv
- imbalance_heavy_5_20251019_144416.csv

analysis methods

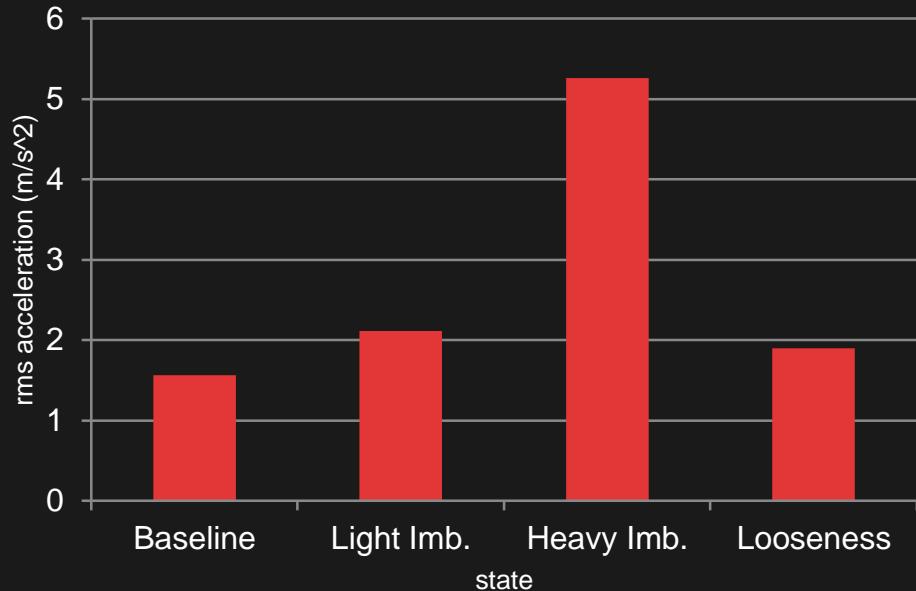
- RMS vibration amplitude
- 1xRPM tone strength (SNR)
- Current ripple monitoring



results: fault detection – vibration analysis

my findings

- Baseline RMS: 1.56 m/s²
- Heavy imbalance: **+238% increase**
- Light imbalance: +35% increase
- Clear fault separation

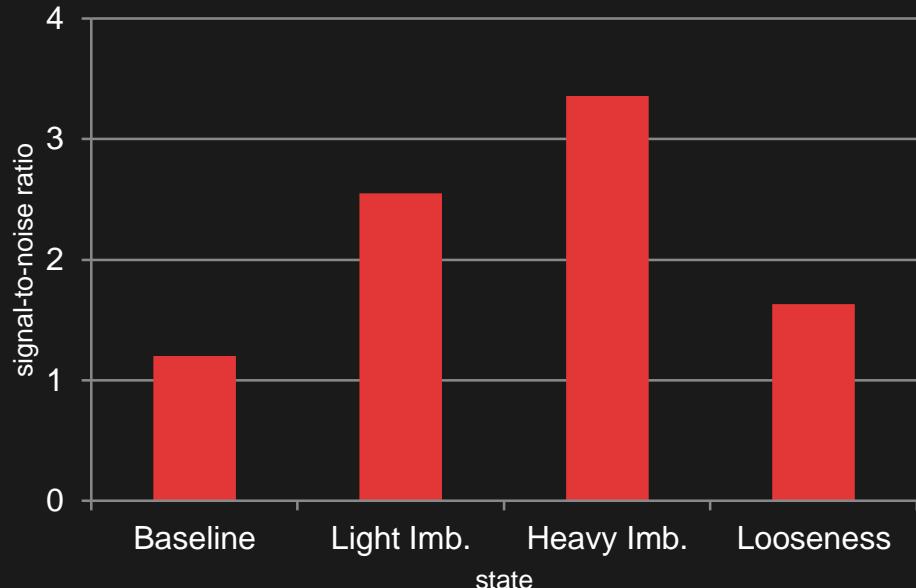


results: fault detection - signal to noise ratio

- How much does da motor shake AT rotation speed (it's rotation frequency) vs random shaking

1xRPM findings

- Baseline SNR: 1.2x
- Heavy imbalance: **2.8x stronger**
- Clear pattern
- Reliable fault indicator



LIVE DEMO

(if it works)

real-time fault detection in action

baseline --> add sim fault --> FAULT DETECTED