User Guide for IDEA: Intelligent Detection Algorithms

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Abstract

This document serves as a comprehensive user guide for the IDEA platform, designed to detect events in power systems through advanced signal processing algorithms. It provides a detailed, step-by-step description of the workflow including data upload, configuration of detection parameters, execution of the analysis, and interpretation of the results. The guide is aimed at engineers and researchers interested in power system stability and wide-area monitoring.

Contents

1 Introduction

IDEA (Intelligent Detection Algorithms) is a modular web-based platform developed to identify events in power system signals. The platform supports frequency-based analysis and uses both time-domain and spectral-domain algorithms. Among the available detection methods are the Min-Max, Fast Fourier Transform (FFT), Yule-Walker, and Matrix Pencil techniques. These are implemented within a sliding window framework to enable localized and adaptive detection of anomalies.

2 Prerequisites

To access the IDEA platform, open a web browser and navigate to:

```
http://148.216.38.78/cict/idea/
```

Ensure your dataset is in CSV format with the following structure:

- First column: Time in seconds.
- Subsequent columns: Frequency values (Hz) from different locations.

3 Graphical User Interface Overview

3.1 Main Interface and Parameters

Once the platform is loaded, the main interface will display the input controls as shown in Fig. 1. Users must specify key analysis parameters before initiating the detection process.

The interface includes the following configurable fields:

- **Select File:** Uploads the CSV file for analysis.
- **Method:** Chooses between Min-Max, FFT, Yule-Walker, or Matrix Pencil.
- **Sampling Frequency (Fs):** Specifies the signal sampling rate (e.g., 10 Hz).
- **Window Size (N_w):** Defines the number of samples per sliding window.
- **Window Separation (H_w):** Sets the step size between consecutive windows.

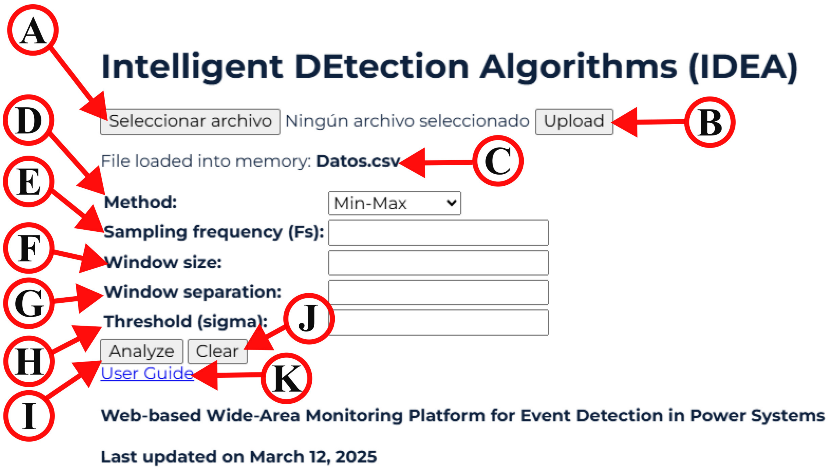

Figure 1: Main IDEA interface with control buttons.

- **Threshold (n_σ):** Multiplier for the standard deviation used in detection criteria.
- **Additional Method Parameters:**
  - FFT: FFT length (e.g., 1024).
  - Matrix Pencil: Tolerance value (e.g., 1×10^{-6}).
  - Yule-Walker: AR model order (e.g., 20).

3.2 Workflow

To run an analysis, follow these steps: First, upload your dataset using the **Select File** and **Upload** buttons. Define the sampling frequency and window parameters based on your dataset characteristics. Next, choose the desired detection algorithm and specify the required algorithm-specific parameters. Once configured, click **Analyze** to execute the detection.

4 Interpreting the Results

Upon completion of the analysis, IDEA displays a frequency vs. time plot where each signal is annotated with red dashed lines at the estimated event times. Users can interactively explore the signals, visualize feature values (e.g., max amplitude, spectral peaks), and assess how each method responds to system disturbances.

5 Case Study: Mexican Power System Event

As an illustrative example, a real-world frequency disturbance from the Mexican power system on December 28, 2020, is analyzed and the preview option shows the signals in Fig. 2. The dataset contains synchronized frequency measurements from five FDRs covering major electrical regions. For this case, the time interval from 200 to 260 seconds was selected, yielding 600 samples with a sampling rate of $f_s = 10$ Hz.

The parameters used were:

- **Window Size:** $N_w = 10$
- **Window Separation:** $H_w = 1$
- **Threshold:** $n_\sigma = 3$
- **FFT Length:** 1024
- **Matrix Pencil Tolerance:** 10^{-6}
- **Yule-Walker Order:** 20

The actual disturbance was recorded at 209.3 s. The estimated detection times were as follows: Min-Max: 209.5 s, FFT: 209.5 s, Matrix Pencil: 209.3 s, Yule-Walker: 211.3 s. Min-max results are shown in Fig. 3. These results demonstrate the effectiveness of each method in capturing the disturbance with different sensitivity and resolution.

Contact Information

For technical support or inquiries, contact `josema95@comunidad.unam.mx`.

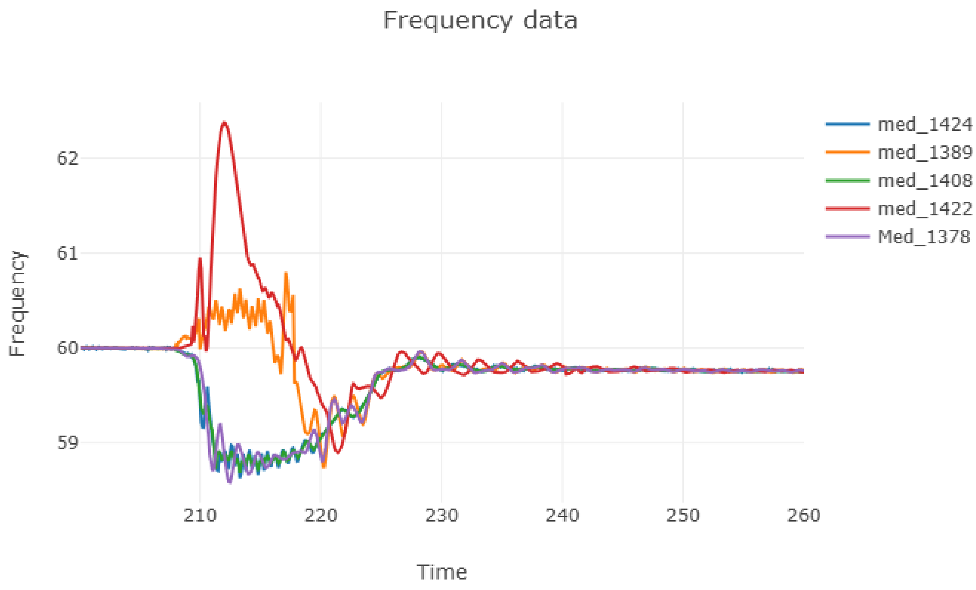

Figure 2: Analysis using the Min-Max method.

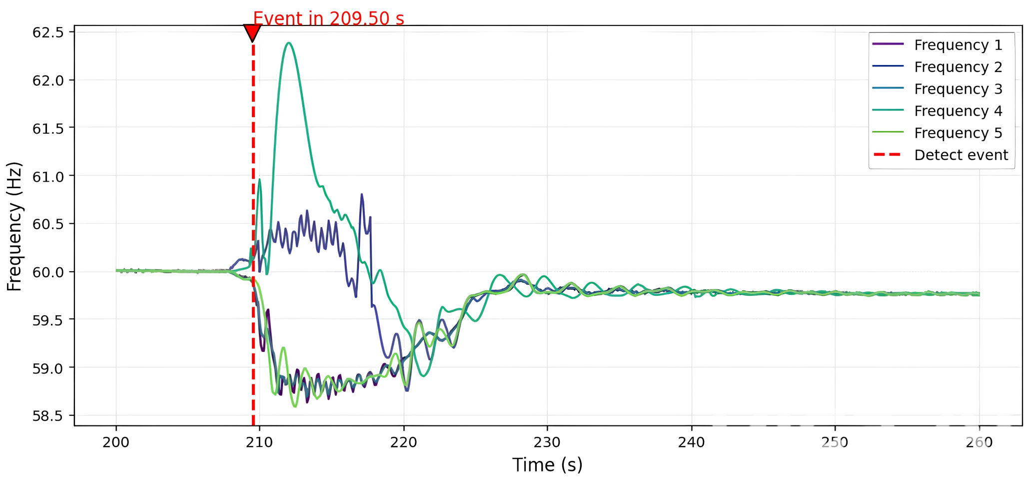

Figure 3: Detected event and timestamp.