IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

System and Method for Predetermining the onset of Impending Oscillatory Instabilities in Practical Devices

IITM Technology Available for Licensing

PROBLEM STATEMENT

- **Oscillatory instabilities** are critical in devices like **gas turbines, jet engines**, and industrial processing devices, causing **performance losses**, reduced operational range, and structural degradation.
- **Detecting these instabilities is challenging**.
- **Techniques to control** them include delay feedback controllers, **combustor stability measurements, exhaust flow** and fuel injection rate modulation, and a detector.
- However, **these methods can increase NO_x** emissions and make it difficult to meet emission norms.
- **Detecting aerodynamic and aeromechanical instabilities** in **turbofan engines** can also be challenging due to similar issues.
- **There is a need to predict instability** and control device parameters to prevent system instability and improve stability margins.

TECHNOLOGY CATEGORY/ MARKET

Technology: Predetermining the onset of impending oscillatory instabilities in devices
Category: Assistive, Test Equipment & Design Manufacturing
Industry: Aviation, Aero acoustic
Application: Gas turbines, Jet engines
Market: The global market size was valued at **US$ 1198.7 million in 2023** and is anticipated to reach **US$ 2250 million by 2030**, witnessing a **CAGR of 9.3%** during the forecast period **2024-2030.**

INTELLECTUAL PROPERTY

IITM IDF Ref. 1734 , Patent No: IN 535504, PCT/IN2019/050533

TRL (Technology Readiness Level)

TRL- 3, Experimental Proof of concept

Research Lab

Prof. Sujith RI**,** Dept. of Aerospace Eng.

TECHNOLOGY

System for Early Detection of onset of Impending instabilities in Practical Devices

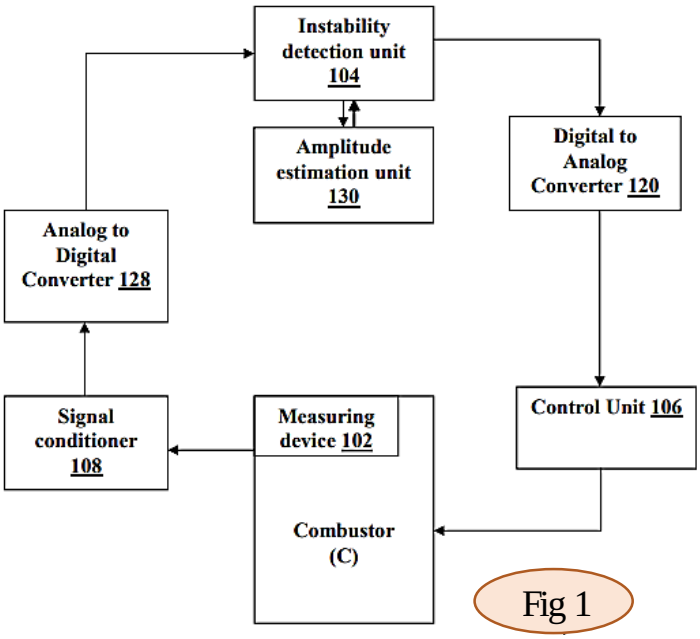

Fig 1

Method for early detection of onset of oscillatory instabilities

1. **Providing** a measuring device in communication with a practical device
2. **Generating** signals corresponding to the dynamics of the practical device
3. **Determining** stability of the practical device from the signals generated from the measuring device and estimating the amplitude of oscillatory instability
4. **Controlling** the parameters of the practical device in accordance with the determined stability of the practical device

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Counting the Bursts Generated within the combustor (C)

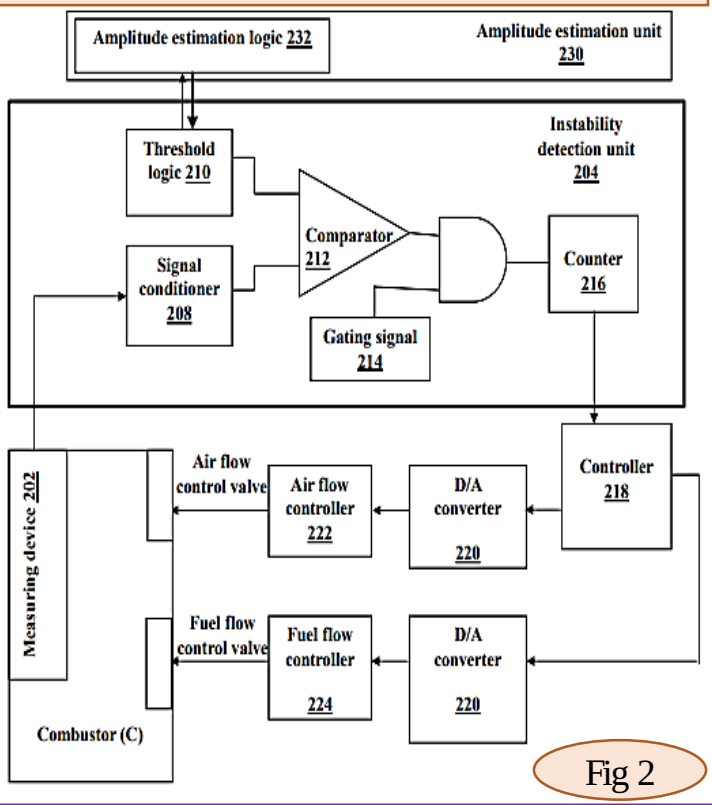


Fig 2

Computing the Hurst exponent

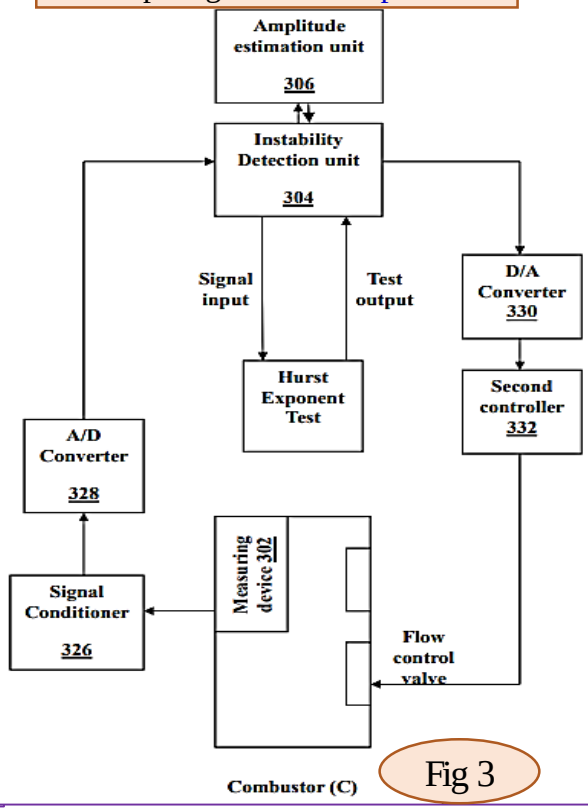


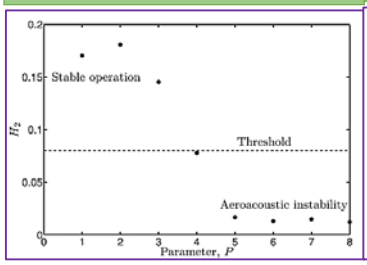
Fig 3

Key Features / Value Proposition

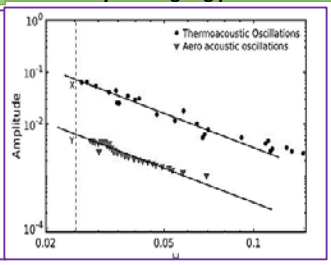
- **Sensors used**
  - **Acoustic sensor, photodiode**, and photomultiplier.
- **Device Proximity to Oscillatory Instabilities**
  - Performs **0-1 test, Burst count test, Hurst exponent test.**
  - Instability detection unit generates values between 0 and 1 based on **instability amplitude and device proximity.**
  - Control unit generates values close to **1 for noisy/chaotic signals, 0 for oscillatory dynamics,** and 0 and 1 for intermittent burst.
  - Device dynamics signal generated using **threshold logic circuit.**
- **Hurst exponent test**
  - Generates values **close to 0 for oscillatory dynamics and 0 and 1** for intermittent bursts.
- **Diagnosis of Intermittent bursts**
  - Using variations in **fractality, multifractality,** or recurrence quantification.

- **Application -** Used to **detect the impending oscillatory instabilities**
  - That proceed through the intermittent bursts in **combustor, an industrial furnace, a burner, aeroacoustic systems, aero-elastic systems, aeromechanical systems, air-compression systems** and any other device subjected to oscillatory instabilities.

A measure based on the Hurst exponent test applied on the dynamic pressure data obtained from an aeroacoustics system



variation of Hurst exponent and the amplitude of the frequency of interest for both aero-acoustics and thermoacoustic instability in a log-log plot



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