SpikeCV Competition (Track 3)

Team name: Spike Symphony

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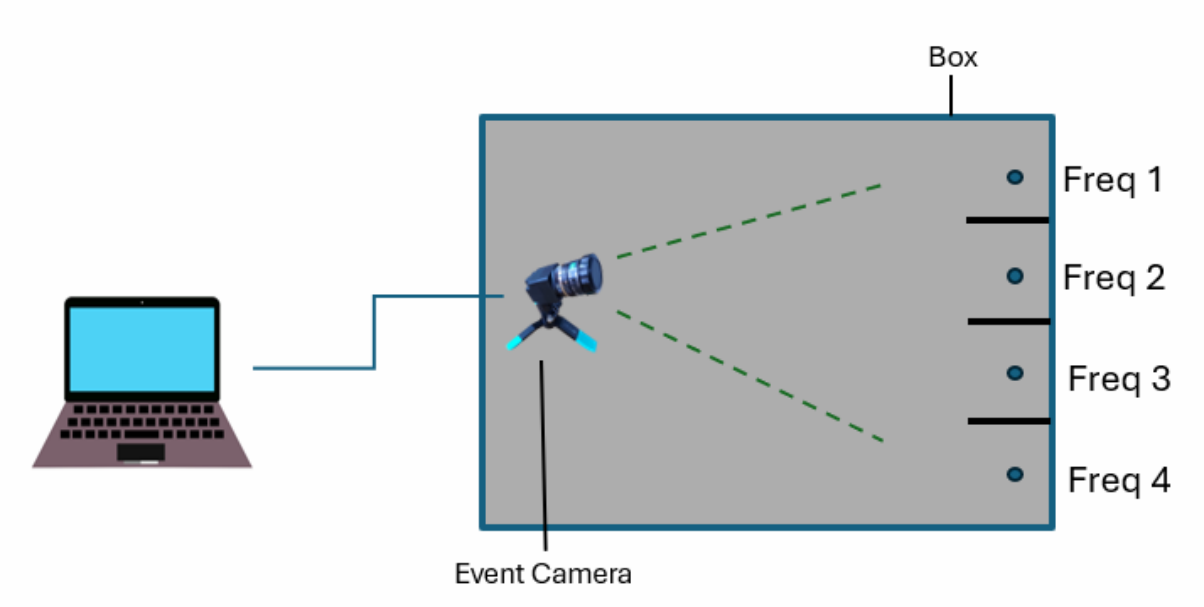
Demo 2: SpecDrum

Imagine a tabletop box whose four upright pegs become your personal drum kit. SpecDrum fuses the ultra-fast vision of an event camera with real-time frequency mapping, turning each peg's micro-vibrations into distinct drum loops. As you tap or oscillate a peg, the camera, mounted inside, captures asynchronous spikes and instantly converts dominant vibration bands into rhythmic beats. A live heatmap display on the external monitor pulses in colour across four vertical regions, syncing perfectly with your motion. Uniform loop lengths guarantee that each sample meshes into a tight groove, while customisable sensitivity and persistence filters ensure only deliberate vibrations trigger hits. The result is an intuitive, highly responsive percussion instrument that delights both performers and onlookers.



Technical Pipeline

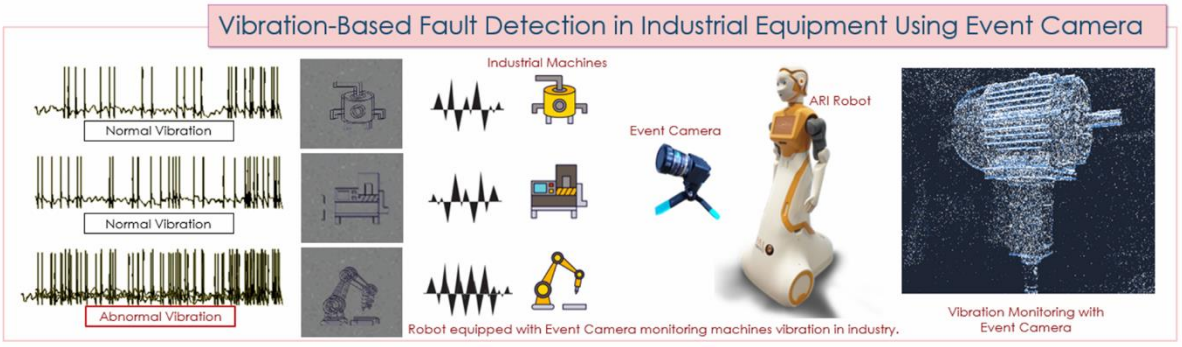
SpecDrum begins by capturing micro-vibrations with an event camera that records pixel-level intensity changes at microsecond resolution. Polarity and activity-noise filters are then applied to eliminate spurious spikes, yielding a clean stream of vibration events. The sensor's field of view is partitioned into four equal vertical zones, each corresponding to one peg, and every zone maintains its own event buffer as well as an independent frequency estimator. At the heart of the system lies our Event-Based Frequency Mapping (EBFM) algorithm, adapted from our ECCV workshop work, which computes per-pixel inter-event intervals to derive instantaneous vibration frequencies. These individual estimates are aggregated across each zone into a dynamic frequency map. To guard against false triggers, the algorithm compares the number of pixels exceeding a configurable frequency threshold against a minimum-events criterion and requires that a region sustain dominance for a user-defined number of consecutive frames before registering a hit. Once triggered, each drum sample loops continuously but is forcibly stopped at

the duration of the shortest sample, ensuring uniform beat length and preventing audio overlap. A 32-voice mixer delivers crisp, polyphonic playback with under 50 ms end-to-end latency, and threaded timers precisely terminate loops for clean, staccato rhythms. Throughout playback, an external GUI displays a colour-coded heatmap of current frequency activity, complete with region dividers, so performers can visualise exactly how peg vibrations translate into sound.

Aitsam, M., Goyal, G., Bartolozzi, C., Di Nuovo, A. (2025). Vibration Vision: Real-Time Machinery Fault Diagnosis with Event Cameras. ECCV 2024 Workshops. Lecture Notes in Computer Science, vol 15646. Springer, Cham. https://doi.org/10.1007/978-3-031-92460-6_18

Real-World Use Cases and Impact

Although SpecDrum showcases the playful potential of event-camera vibration mapping, the underlying EBFM framework has proven value in a variety of industrial and scientific domains. In predictive maintenance, it permits non-intrusive monitoring of rotating machinery to detect early signs of bearing wear or imbalance before catastrophic failure. For structural health monitoring, continuous analysis of resonant frequency shifts in bridges, buildings and aerospace components can reveal material fatigue long before visible damage occurs. In robotics, ultra-fast vibration sensing enables closed-loop control that adjusts to mechanical oscillations in real time, enhancing precision and fault diagnosis. Finally, in smart infrastructure applications, the technique can classify traffic flow via vehicle vibration signatures and power real-time analytics for smart-city deployments. SpecDrum exemplifies the technical elegance of event-based frequency mapping and highlights its transformative potential across research and industry.



Demo Video