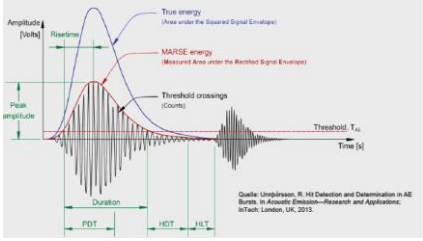
Chair of Computing in Civil and Building Engineering
TUM School of Engineering and Design
Technical University of Munich

Modeling:
Mathematics:
Programming:
Science:

Software Lab: High-Frequency Sensor Data Streaming on Heterogeneous Architectures

Description



Acoustic Emission (AE) sensing is used to detect material stress, crack formation, and dynamic structural behavior.

The modern sensor systems used in acoustic emission, vibration monitoring, or ultrasonic inspection generate continuous data streams at sampling rates of several megahertz. Processing these streams in real time poses significant challenges: latency constraints, limited computing resources on embedded platforms, and the need for efficient memory handling. This project explores how different programming languages and hardware architectures address these challenges.

The **objective** of this project is to design, implement, and evaluate a modular streaming pipeline for high-frequency sensor data. Students will compare implementations across **Python, Rust, and C++**, deploy on different target platforms (x86, ARM, GPU), and analyze trade-offs in performance, resource usage, and development complexity—with a focus on **edge deployment**.

Tasks

- Study existing streaming frameworks and identify requirements for high-rate data ingestion (>1 MS/s).
- Develop equivalent pipeline modules in for example Python, Rust, and C++
- Deploy and benchmark on x86 (desktop/server), ARM (Raspberry Pi / NVIDIA Jetson), and optionally GPU.
- Apply platform-specific optimizations (SIMD, async I/O, zero-copy buffers, real-time scheduling).
- Measure latency, throughput, CPU/memory footprint; document trade-offs.
- Document all components and produce a final system demo.

Supervisor

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References

Unnþórsson, Rúnar. "Hit detection and determination in AE bursts." Acoustic emission-research and applications 1.1 (2013).