Design and Implementation of a Low-Latency Ethernet-Based Audio Interface

Student

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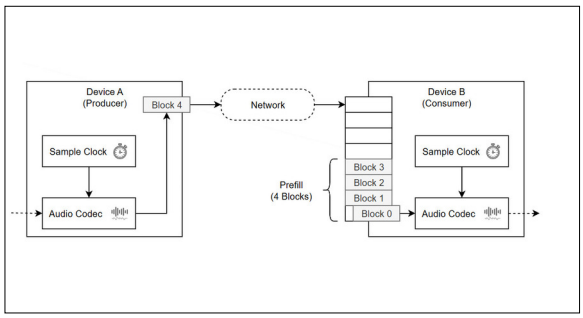
Introduction: Loft Dynamics AG develops virtual reality (VR) flight simulation training devices. During training sessions, pilots and instructors use headsets to communicate with each other. The current version of the communication system relies on analog circuits. While previous work has already demonstrated digital audio mixing, this project focuses on identifying, implementing, and evaluating a suitable low-latency digital audio interface to replace the analog connections.

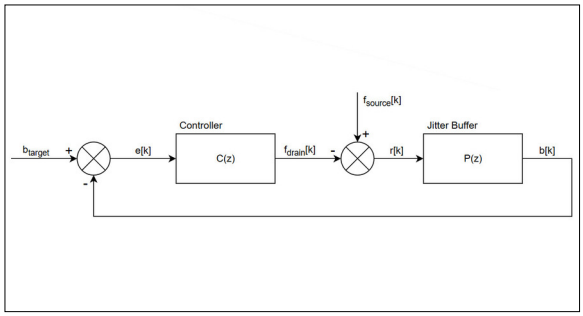
Approach: A system was designed to connect multiple devices over an Ethernet-based audio network. These include a Windows-based PC running the flight simulation and embedded devices that provide an interface between the headsets and the network. The application running on the embedded devices is based on the real-time operating system Zephyr, enabling concurrent processing and improving software portability. Network jitter buffers are employed to ensure stable audio streaming. In addition, to compensate for clock drift between the devices in the network, a control loop was designed to adapt the local sampling frequency as required. The system was evaluated in a simple test setup comprising two embedded devices and a PC node.

Result: The developed prototype enables full-duplex, high-fidelity audio streaming between all devices in the network. While sufficiently low end-to-end latency was achieved between the embedded devices, the Windows-based counterpart revealed limitations in real-time performance imposed by the operating system. Overall, the project demonstrates the feasibility of an Ethernet-based audio network as a low-latency digital audio interface and provides a foundation for further development.

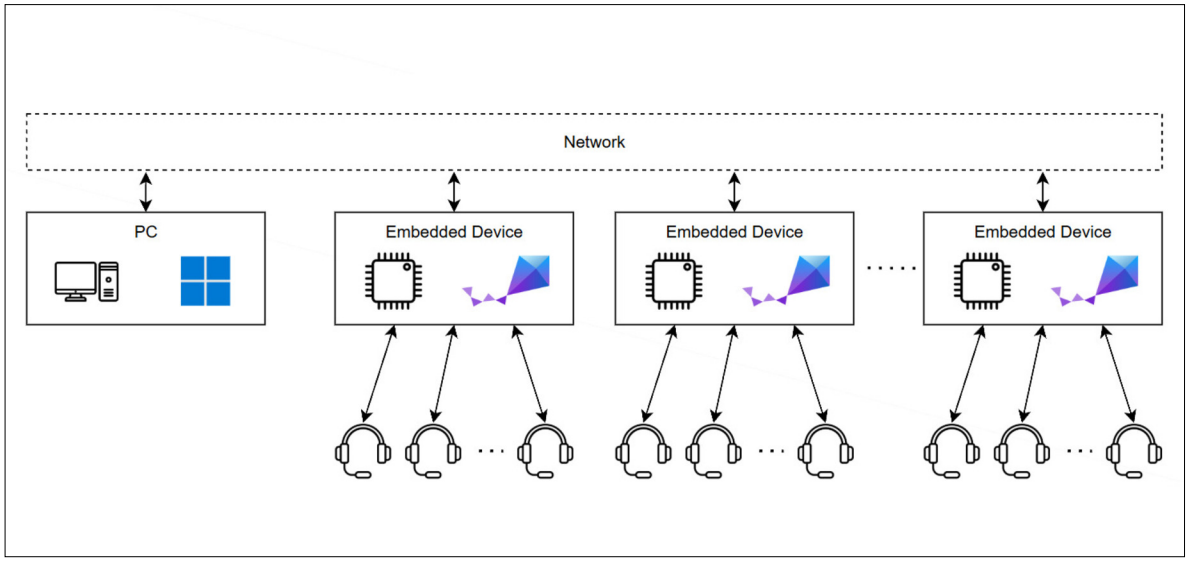
Jitter Buffer
Own presentment



Control Loop
Own presentment



Audio Network
Own presentment



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