

TLDR: A super-lightweight video compression designed for Microcontrollers that produces an adaptive bitstream, slashes bitrate by 55% compared to M-JPEG (the only existing video encoder on MCUs).

Nobody thought about MCUs!

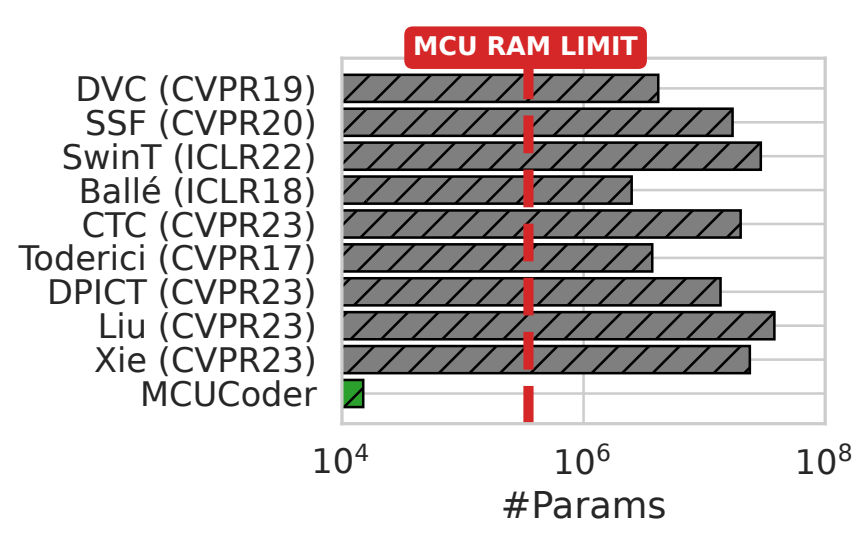
The rapid growth of camera-based IoT devices, used in surveillance, smart farming, and more, demands efficient video compression. However, IoT devices face two significant challenges:

- **Constrained Hardware:** Only 1–2MB RAM and low computational resources.
- **Limited and Unstable Internet:** Real-time video transmission requires adaptive bitrate.

Existing solutions:

- Traditional and deep encoders demand high computational resources, memory, and energy, making them unsuitable for MCUs.

M-JPEG is the only viable option for MCUs.



MCUCoder is here for IoT!

Ultra-lightweight Encoder:

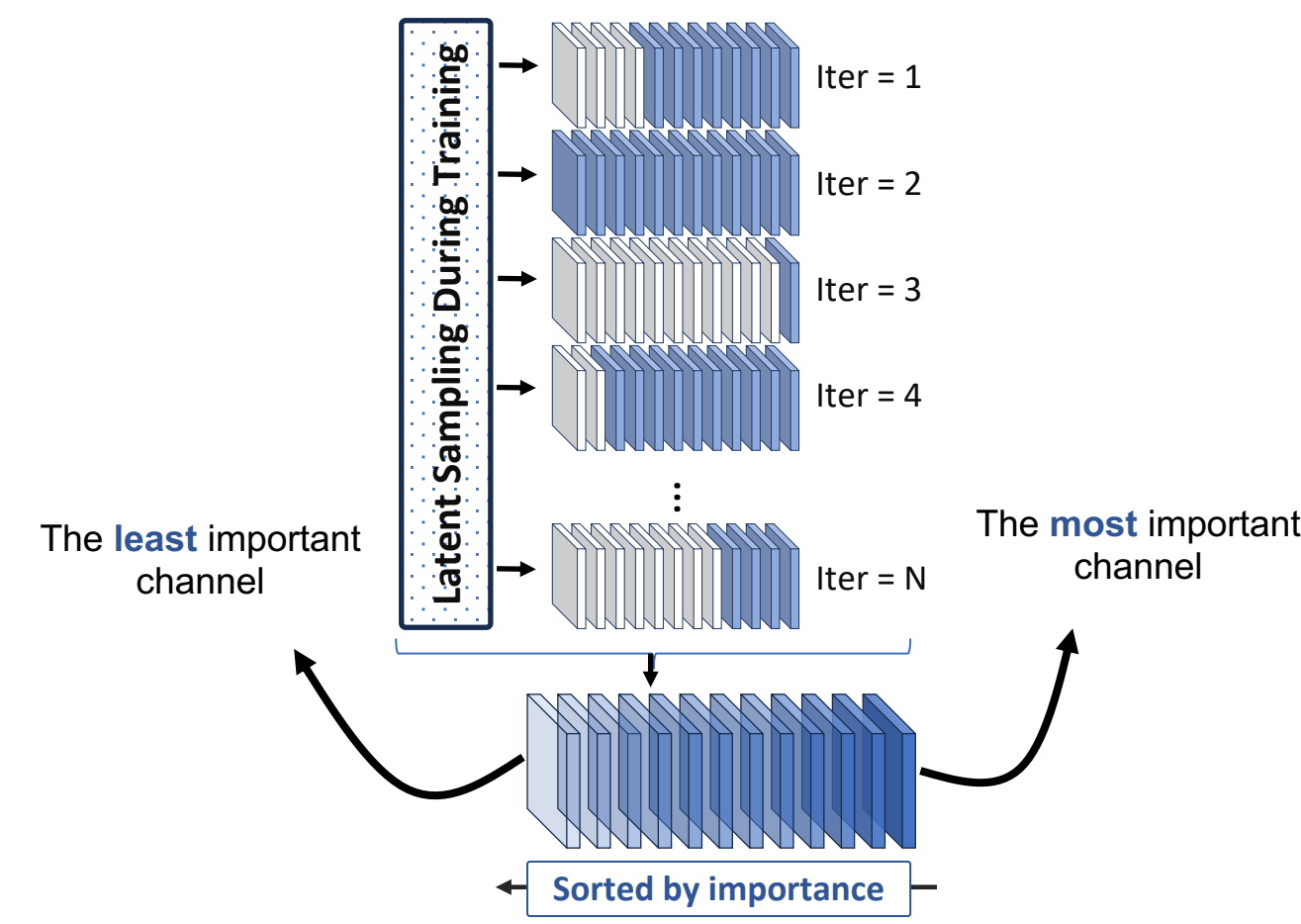
- Only 10.5K parameters and 350KB RAM footprint.

Energy Efficient:

- INT8 quantized encoder for low power consumption using DSP and CMSIS-NN.

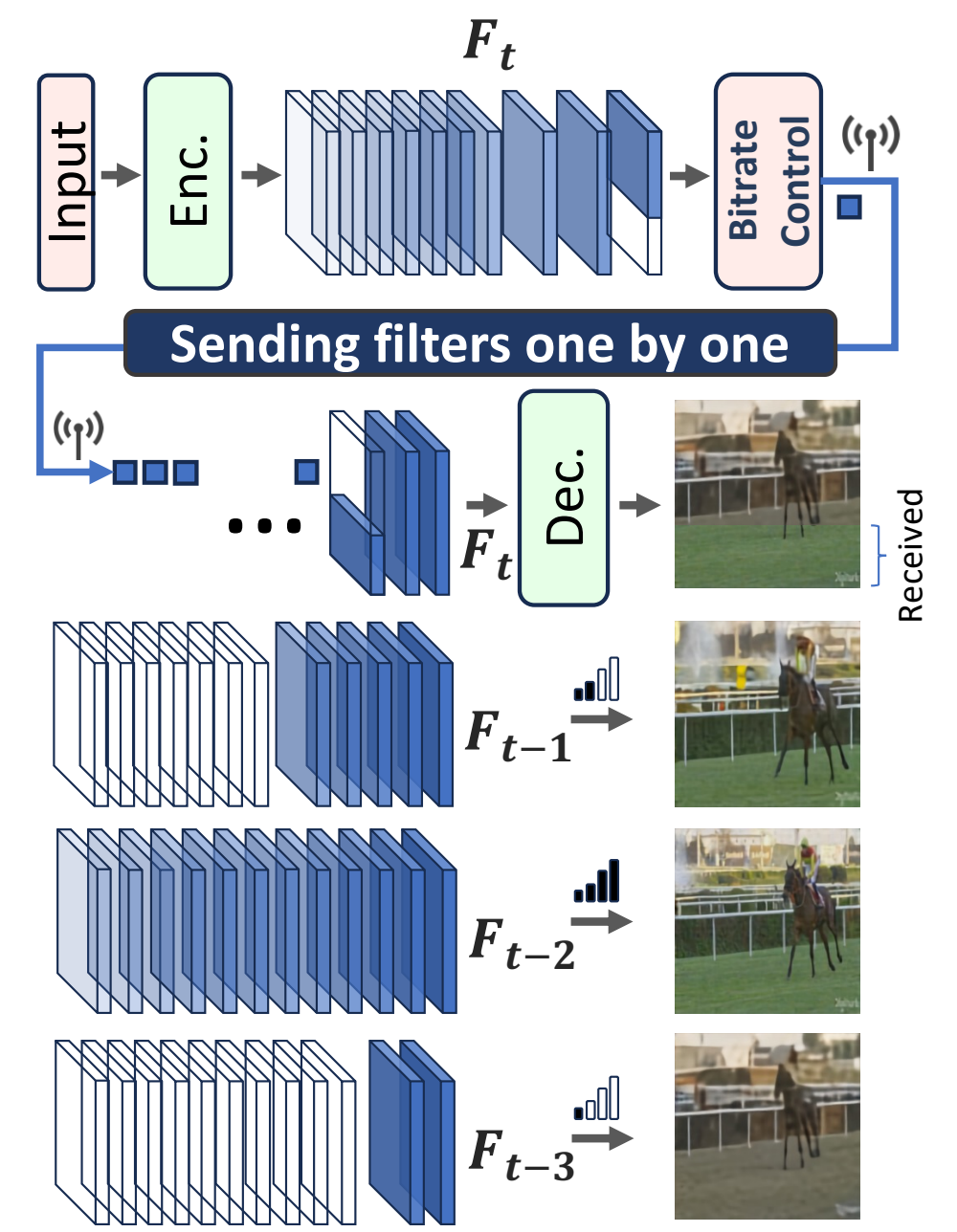
Adaptive Bitrate Streaming:

- Latent channels are ordered by importance during training, enabling zero-cost adaptive streaming.

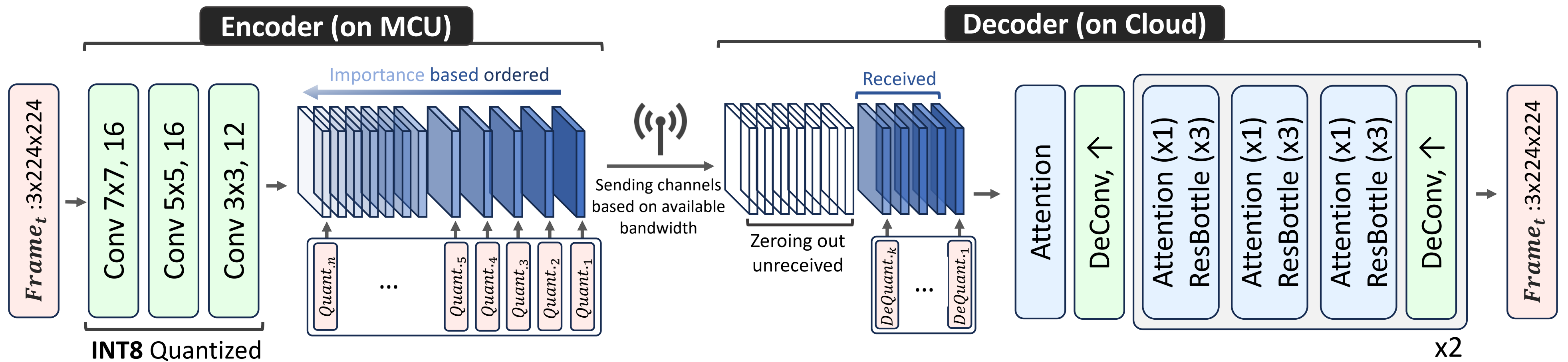


MCUCoder in practice

- An example of MCUCoder bitrate adaptation under dynamic network conditions, with the control module regulating the number of channels to transmit.

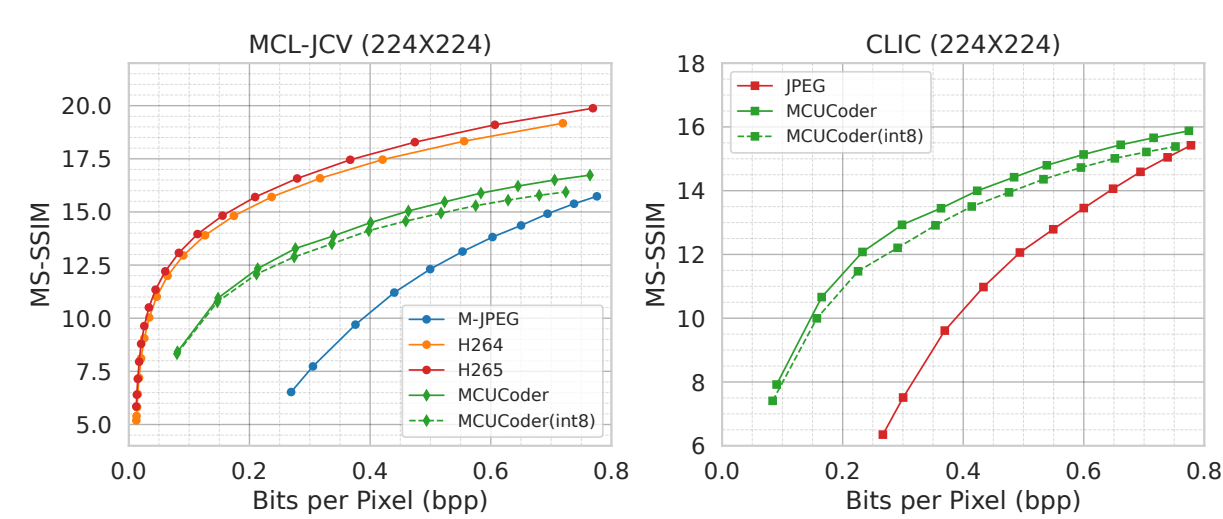


MCUCoder Architecture



MS-SSIM and PSNR

- MCUCoder outperforms M-JPEG.



MCUCoder (Quantized) BD-rate results. The anchor is M-JPEG.

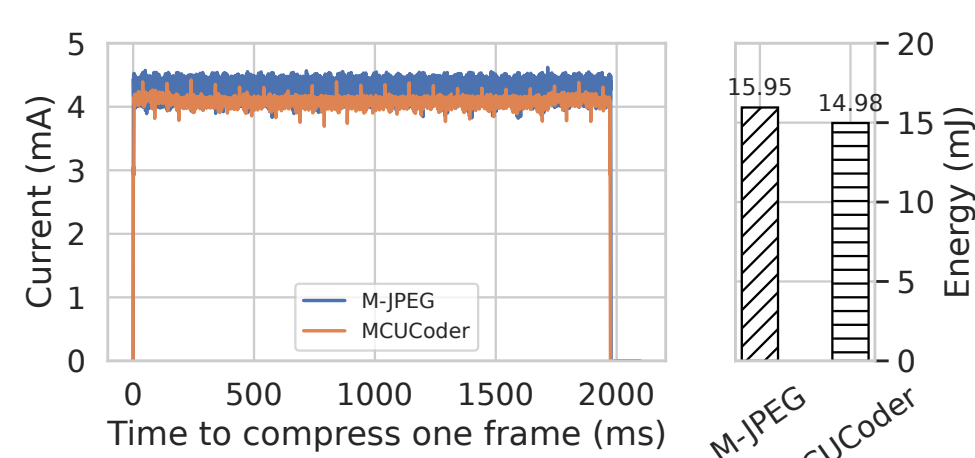
Type	Dataset	MS-SSIM	PSNR
Video	MCL-JCV	-55.65%	-47.39%
	UVG	-55.59%	-35.28%
Image	KODAK	-55.75%	-43.01%
	CLIC	-49.54%	-38.02%

How does it impact battery?

- MCUCoder is as energy efficient as M-JPEG.

Resource demands of MCUCoder on nRF5340 and STM32F7 MCUs.

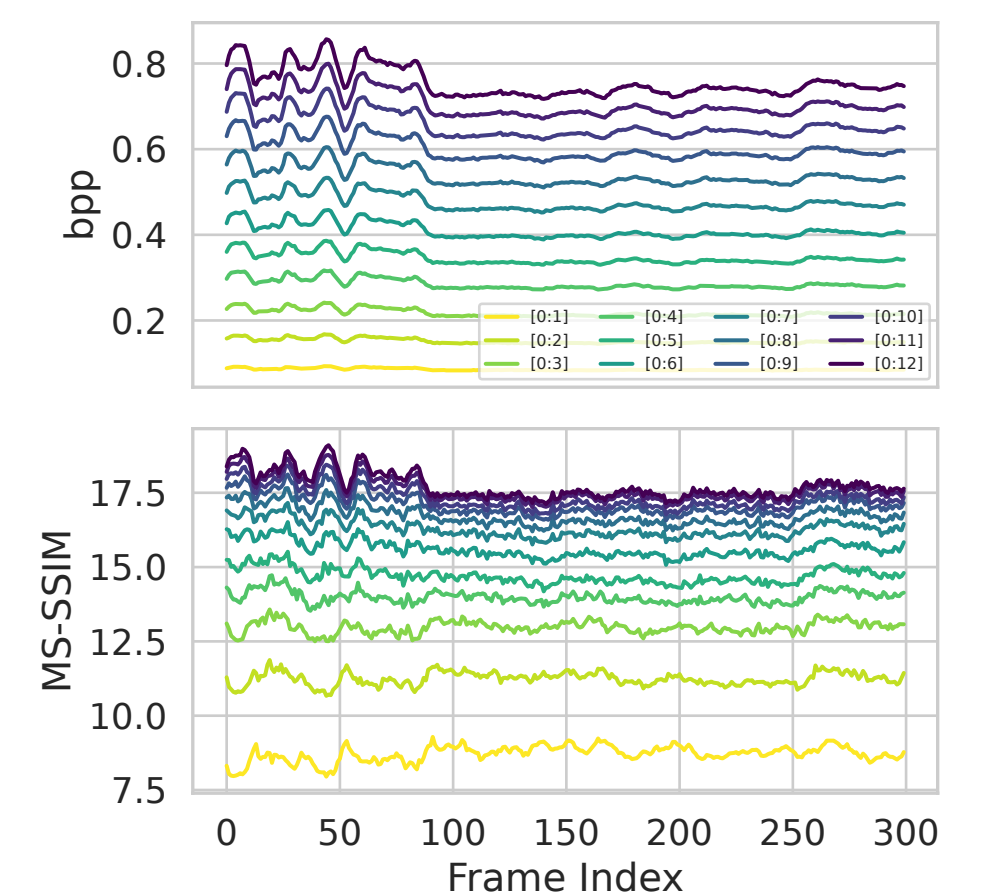
	nRF5340	STM32F7
Exec (ms)	1,969	237
RAM (KB)	344 (33%)	360 (17%)
Flash (KB)	100 (10%)	107 (5%)



Energy and current consumption of MCUCoder

Streaming channels

- MS-SSIM and bpp for a sample video, with "[0:k]" indicating the number of channels used for decoding.



Conclusion

- MCUCoder is an ultra-lightweight encoder (10.5K params, 350KB RAM) for IoT devices.
- Its INT8 encoder reduces bit rate by 55.6% with JPEG-level energy efficiency.
- It supports adaptive bitrate streaming for robust video transmission.

