Sustainable Video Compression Prototype for Reducing Energy Use

BIRMINGHAM CITY University

Vanessa Addo – 22123673
vanessa.addo@mail.bcu.ac.uk

Introduction

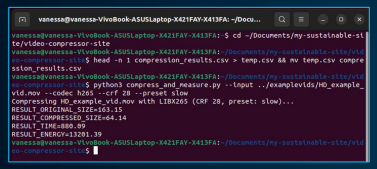
- Video streaming is now the dominant source of internet traffic and data usage globally.
- This growth increases energy consumption across data centres, networks, and devices.
- Despite debates, the environmental impact of streaming is a valid concern.
- As demand for HD and 4K grows, sustainable digital practices are urgently needed.
- This project designs and tests sustainable video compression methods to reduce energy use and emissions.
- Chachou et al. (2024): Found video encoding to be a major contributor to energy use and carbon emissions.
- Katsenou et al. (2022): Analysed energy-quality trade-offs in video codecs to guide sustainable compression choices.

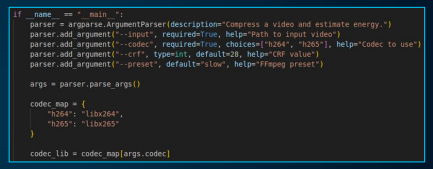
Aims & Objectives

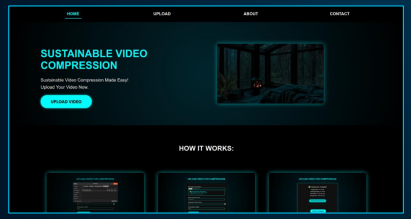
- To research and analyse video compression algorithms and energy impact
- Develop a prototype that will apply multiple codecs to the users uploaded videos
- To investigate and choose appropriate methods for measuring the energy used during compression
- Create a web interface that automatically applies the best energy-efficient compression to users' videos
- Evaluate the success of the prototype website and provide recommendations for future work

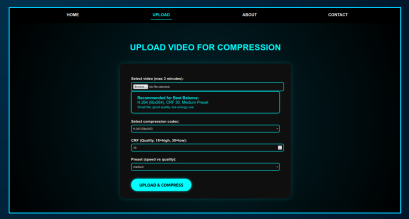
Methodology

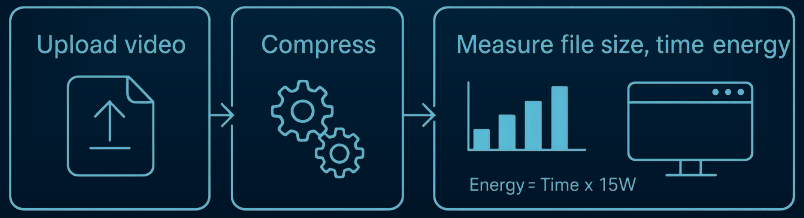
- Experimental Methodology with quantitative data was used.
- Developed a Python script (compress_and_measure.py) to test sustainable compression using H.264 and H.265 codecs.
- Adjusted compression settings using CRF values (24–30) and preset levels (slow, medium, fast).
- Energy consumption was estimated using the formula:
  Energy (Joules) = Compression Time (Seconds) × 15W (based on Intel i5-10210U CPU's average power draw)
- All results (time, size, estimated energy) were saved in a CSV file.
- Built a Flask-based website to allow users to upload and compress videos with selected settings.
- The goal was to assess the performance of existing popular codecs such as H.264 and H.265 Coconut (2024), by file size, processing time of compression and the energy consumption.











Results

Best configuration: H.264, CRF 30, preset medium
- HD: reduced from 163MB to 38MB
- Energy use: 1,796.54 J

H.265 required more time and energy, especially with slow presets

For 4K video:
- H.264 CRF 30 medium → best balance (from 182MB to 157MB, 4,928 J)
- H.265 CRF 28 medium → unexpected increase in file size

Key takeaway:
- H.264 was more sustainable than H.265 on the testing setup

Conclusions & Future Work

- Sustainable compression is achievable using the right settings.
- H.264 (CRF 30, medium) gave the best results for size, time, and energy.
- Energy was estimated using a simple CPU-based formula.
- The web tool makes eco-friendly compression accessible.

Future Work:
- Add AV1 and GPU support
- Automate quality checks
- Improve user feedback and UI

References:
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