LIVERPOOL JOHN MOORES UNIVERSITY

An Electric Network Frequency Analysis Technology Demonstrator for Educational Purposes

Dr Karl O. Jones
Lewis Hamilton
Dr David L. Ellis
Colin Robinson
Jago T. Reed-Jones
Kay Morrison

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Introduction

- Authenticating digital audio is a crucial task for Audio Forensic Technicians (AFT) owing to increased use of digital multimedia in both criminal and civil courts.
- Analysing the electric network frequency (ENF), often unintentionally embedded when recording digital audio, is a critical authentication tool.
- Increasing use of digital media in court means there is a growing demand for AFTs – this has raised demand for appropriate education.
- Thus, ENF analysis should be key in the education of future audio forensic technicians.
- A device for educational purposes has been designed to demonstrate the technology and procedures involved in ENF analysis, providing future AFTs with practical experience in a key authentication technique.

ENF Device Design

- For the frequency of the mains to be accurately determined, the mains signal must be registered by a form of computer device with suitable software development.
- A Raspberry Pi (RPi) was chosen because it is arguably the most popular single-board computer on the market.

Practical Implementation Results

- Firstly, the RaspberryPi ENF device collected data over an hour-long period from 18:00 on 31st October 2020 to match the ENF data with data from the National Grid
- Secondly, an exemplar audio recording was created during the RPi data collection period, the aim being to confirm precisely at which point was recorded during the hour.

Audio Recording (*Audio1.wav*)

- To extract the frequency information from the audio recording, the *Audio1.wav* file was loaded into iZotope RX audio restoration software and a random sample of 1 minute in length was taken.
- The audio was split into windows of equal length, and frequency for each window calculated manually via the FFT spectrum analyser module in RX7.
- Data from each window was manually inputted to Microsoft Excel, which is unsustainable and is extremely labour intensive.
- In terms of an educational exercise then this approach is of value for students to appreciate the whole analysis process.

Results - ENF

- Visual comparison of the RPi data and the NGC data shows a very good match, particularly in the shape of the curve.
- The actual RPi recorded data did not precisely match the NGC provided data, however the difference between the two values at each sample is small being in the range ±0.03% (*maybe down to rounding function in the RaspberryPi*).
- From a forensic perspective, since the primary function is the determine the time period an audio recording was made, having a small error for each sample is not a significant issue since the overall match of actual frequencies compared to recorded frequencies is the critical factor

Results – Audio Recording

- In relation to the audio recording made on the iPhone, the frequency data points extracted from 1 minute from the 17 minutes of *Audio1.wav* were subsequently plotted and compared against the RPi data and the NGC dataset.
- Correlation coefficient of 0.88 was calculated for the *Audio1.wav* frequency values against the RPi determined frequencies, while the coefficient was 0.96 for the correlation between extracted Audio1.wav data and NGC values.
- The *Audio1.wav* extracted ENF data had a slightly better correlation with the NGC database than with the RPi determined data.

Conclusions

- The RPi device can obtain highly accurate data from the electrical mains.
- It can be concluded that the device would be compatible for use in an educational setting since the technology and principles of the data collection aspect of ENF analysis can be demonstrated to a high level.
- However, in its current state, the device requires further development to render it fully operational for students to use as a practical tool when learning how to authenticate digital audio.