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A comparative study of audio latency feature of Motorola and Samsung mobile phones in forensic identification

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Abstract

Background: In forensic science the process of proving authenticity of audio recording plays an important role. In recent times, Forensic experts mostly receives digital recording for authentication as compared to analog recording. A digitally altered audio signal, leaves no visual indications of being tampered, and it will be indistinguishable from an original audio signal. **Objective**: To highlight the significance of latency feature of mobile phone handsets in forensic science via comparing input audio latency feature of Samsung and Motorola mobile phone in two audio formats. **Methods**: In this work two well-established and most used brands of mobile phones were considered for comparison: SAMSUNG and MOTOROLA. In the present paper, the digital audio samples have been recorded using 20 mobile phones of various models from two different makes i.e. SAMSUNG and MOTOROLA, in two audio formats i.e. WAV and 3GP. Audio samples were then analysed using Adobe Audition 3.0 software for the input audio latency feature of mobile phones and compared. **Findings**: Input audio latency value of digital audio recordings can be helpful in forensic identification of make and model of source mobile phone. **Novelty**: A new technique in digital forensics, to classify the given audio samples on the basis of input audio latency feature and identifying the make of source mobile handsets.

Keywords: Authentication; digital audio; forensic science; adobe audition; mobile phone

1 Introduction

Digital forensic study began as a result of rise of digital crimes due to increase in use of digital technology. The proliferation of digital technology not only increased the online communication and criminal activity (with the use of the digital device either as instrument or target or both in committing criminality) but also increases challenges for forensic investigators on how to deal with complex and sophisticated criminal activities.

Since 1984 various methods have been developed for investigating these sophisticated crimes, depending upon incident response or for admissibility in court. There is no specific protocols for investigations, since digital forensics is relatively new field in forensic science in comparison to other disciplines. Every organization and country have its own standard operating procedure for investigation based on technology aspect, data of investigation, and other aspects of investigation. [1]

The most normal way of communication between human beings is speech. Nowadays, mobile phones are commonly used in society as a cheap, sophisticated, and indispensable communication tool. In Mobile phones information is received, processed, transmitted, and stored in digital form. This implies a lot of information can be stored in mobile phone either in form of audio recording or video recording or text messages, having evidential value. An important step in digital speech forensics is phone identification. [2]

Firstly, one needs to know the process involved in the production of audio recording by analysing the audio signal [3]. That implies, to identify the acquisition device by supposing that the digital device leaves intrinsic traces in audio signal at the time of processing of audio recording. Certainly, no two devices will have exactly same frequency response due to the variation in designs employed by the different makers [4]. Hence, the spectrum of recorded audio signal can be considered as a product of the genuine audio signal spectrum. Subsequently, the recorded audio signal can be used in digital device identification, following a blind-passive approach, in contrast to active embedding of watermarks or having access to input-output pairs.

Though a long way to go for making audio forensics acceptable in the court as an evidence and in reference to image forensics audio forensics is far behind [5]. In last few years the researcher on audio forensics has flourished. Its undeniable fact that digital technology benefitted to our generation and nowadays it's become easy to alter audio recordings contents using easily available free software packages and tools. Several issues in digital audio recordings have attracted the curiosity of the forensics community, like copy-move forgery, deletion, addition, substitution and splicing of forged audio may involve merging recordings of different digital devices [6], codec identification, speaker authentication, identification of source of digital device, identification of the network traversed, and acquisition device identification. However, whatever the case may be, these challenges are addressed depending upon the characteristics information available on the content to be examined. [7]

Nowadays multimodal interaction is very common in number of digital devices, although devices are becoming faster, operating systems and applications are complex like in case of touchscreen mobile phones. This results latency in interaction, and can disturb the usage and the handler experience. It has been said that end-to-end latency of a system is one of the most significant problem which restrict the quality, interactivity and effectiveness of virtual reality, as well as head mounted display systems. Wright et al. [8] assert that several milliseconds of latency and jitter can create the difference between a responsive, expressive, satisfying real-time computer music instruments.

When we use a mobile phone, we expect it to respond immediately to our voice but each and every mobile handsets shows different amount of time delay until its actually start recording i.e. input audio latency, in the phone depending on the depending upon the device driver design used by the maker of the mobile phone, it can be prompt, but in some cases this time delay could be several hundred ms. Since, no two manufacturers of mobile phones can use exact same driver design, we will always find differences in input audio latency with change in make of mobile phone. We can use this time delay feature of mobile phones for classifying the audio samples recorded from different sources and to identify/link the given audio recordings with its source mobile phones. Hence, measuring and understanding latency is important in forensics.

This paper presents a comparative study of input audio latency feature in audio samples recorded from SAMSUNG and MOTOROLA mobile phones in two different formats and its forensic significance.

2 Methodology

The Adobe Audition 3.0 software is a comprehensive toolsets that comprises features such as a multi-track, waveform and spectral display for creating, mixing/editing and restoring audio content and non-destructive waveform analysis [9]. For the complete experiment process, the same software was utilized to analyse the spectral display of audio files and measure input audio latency value. To study the characteristic feature of SAMSUNG and MOTOROLA mobile phone in reference to audio latency. Here, twenty direct recordings in two different formats, i.e. wav and 3gp have been recorded from each mobile phone in different recording sessions (ten direct recordings in each format). The audio files which are recorded in 3gp format are than converted into wav format using Format Factory Application for the purpose of analysis. All the recordings of each mobile phone are utilized for examination of the pattern of audio latency and to measure its value.

3 Results and Discussion

400 audio samples have been recorded using EASY VOICE RECORDER APP. Ten mobile handsets of each SAMSUNG and MOTOROLA make but different models in two audio recording format i.e. wav & 3gp & analysed with ADOBE AUDITION

3.0 software. Following inferences are drawn:-

- The mobile phones of make Samsung shows significant input latency time in both audio formats, while mobile phones of Motorola make shows negligible input audio latency time in wav and 3gp format.[10] (Refer Tables 1 and 2)
- The input audio latency time lies in the range of 0:00.130ms to 0:00.140ms in case of audio recordings recorded using Samsung mobile phones in 3gp format and in wav format input audio latency value lies below 0:00.200ms. (Refer Table 1)

The input audio latency time as measured using Adobe Audition 3.0 software, for various mobile phones of Samsung and Motorola make has been depicted in Tables 1 and 2 respectively. We observed a significant difference in input audio latency value between the audio recordings recorded using mobile phone of SAMSUNG make and MOTOROLA make. It is clearly seen from the table that mobile phone of SAMSUNG make always shows an input audio latency value for audio signal in 3gp and wav format while audio samples recorded from MOTOROLA mobile phone shows negligible input audio latency in both the formats. Hence, on the basis of input audio latency value of audio recordings in given format we can differentiate between the audio samples recorded from different mobile phones and identify the manufacturer of mobile handsets between SAMSUNG and MOTOROLA mobile phone. It will narrow down the area of search. Hence, input audio latency time of mobile phones makes as an important class characteristic in forensic examination. The input audio latency pattern of SAMSUNG and MOTOROLA mobile phones are depicted vide Figures 1, 2, 3 and 4. Spectral display of audio recordings recorded using Motorola mobile phone in wav and 3gp format showing negligible input audio latency time is given in Figures 1 and 2 while spectral display of audio recordings recorded using SAMSUNG mobile phones in wav format and 3gp format showing significant value is given in Figures 3 and 4 .

Table 1. Measurement of input audio latency time in various mobile phones handsets of SAMSUNG make

S.No.	Mobile make	Mobile model	Sampling Rate (Stereo)	Input Latency Time (mm:ss.ddd)	
				wav	3gp
1	SAMSUNG	J7	16000 Hz	0:00.008	0:00.135
2	SAMSUNG	J5	16000 Hz	0:00.127	0:00.137
3	SAMSUNG	NOTE 5	16000 Hz	0:00.035	0:00.137
4	SAMSUNG	A8	16000 Hz	0:00.100	0:00.131
5	SAMSUNG	J7	16000 Hz	0:00.125	0:00.133
6	SAMSUNG	J5 PRIME	16000 Hz	0:00.040	0:00.139
7	SAMSUNG	GRAND 2	16000 Hz	Negligible	0:00.137
8	SAMSUNG	GALAXY S DUOS	16000 Hz	0:00.175	0:00.137
9	SAMSUNG	SM A 500G	16000 Hz	0:00.125	0:00.130
10	SAMSUNG	J5	16000 Hz	0:00.040	0:00.131

Table 2. Measurement of input audio latency time in various mobile phones of Motorola make[8]

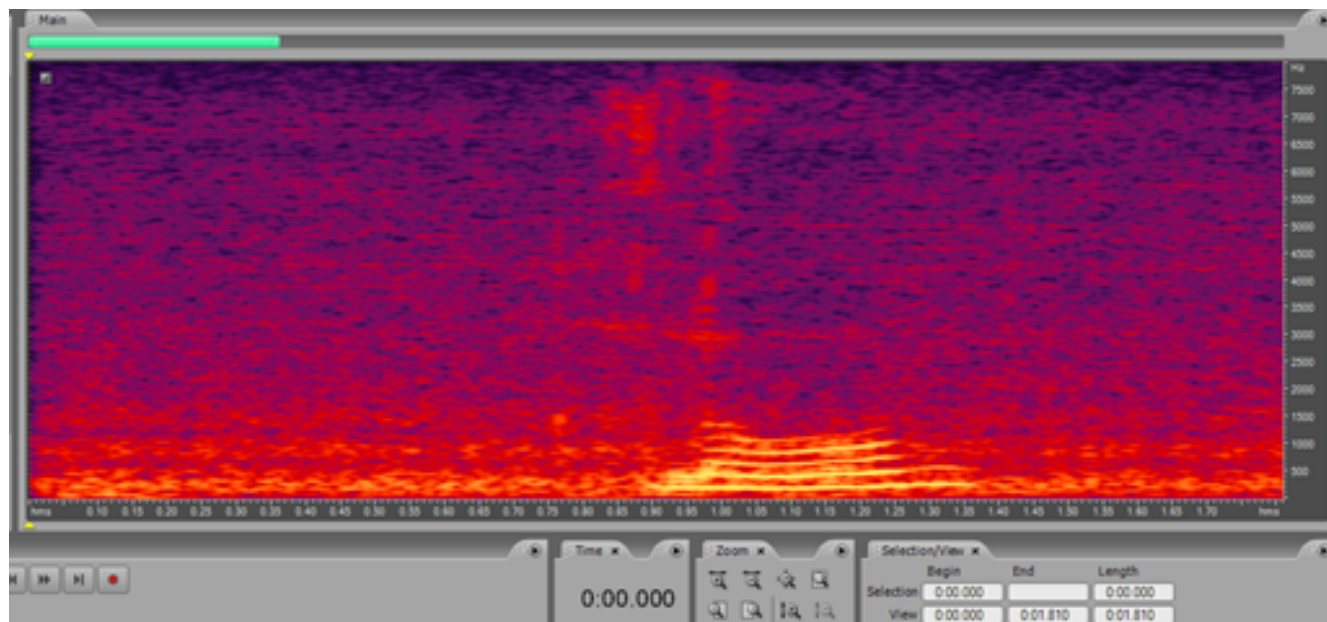| S.No.	Mobile Make	Mobile Model	Sampling Rate	Input latency time	
				wav	3gp
1	Motorola	G4 plus	16000 Hz	Negligible	Negligible
2	Motorola	G4 plus	16000 Hz	Negligible	Negligible
3	Motorola	XT 1068	16000 Hz	Negligible	Negligible
4	Motorola	X play	16000 Hz	Negligible	Negligible
5	Motorola	E4 plus	16000 Hz	Negligible	Negligible
6	Motorola	G4	16000 Hz	Negligible	Negligible
7	Motorola	G5S	16000 Hz	Negligible	Negligible
8	Motorola	X Play	16000 Hz	Negligible	Negligible
9	Motorola	G 4 plus	16000 Hz	Negligible	Negligible
10	Motorola	G5S	16000 Hz	Negligible	Negligible

Fig 1. Pattern of input audio latency in MOTOROLA G4 PLUS mobile phone in wav format
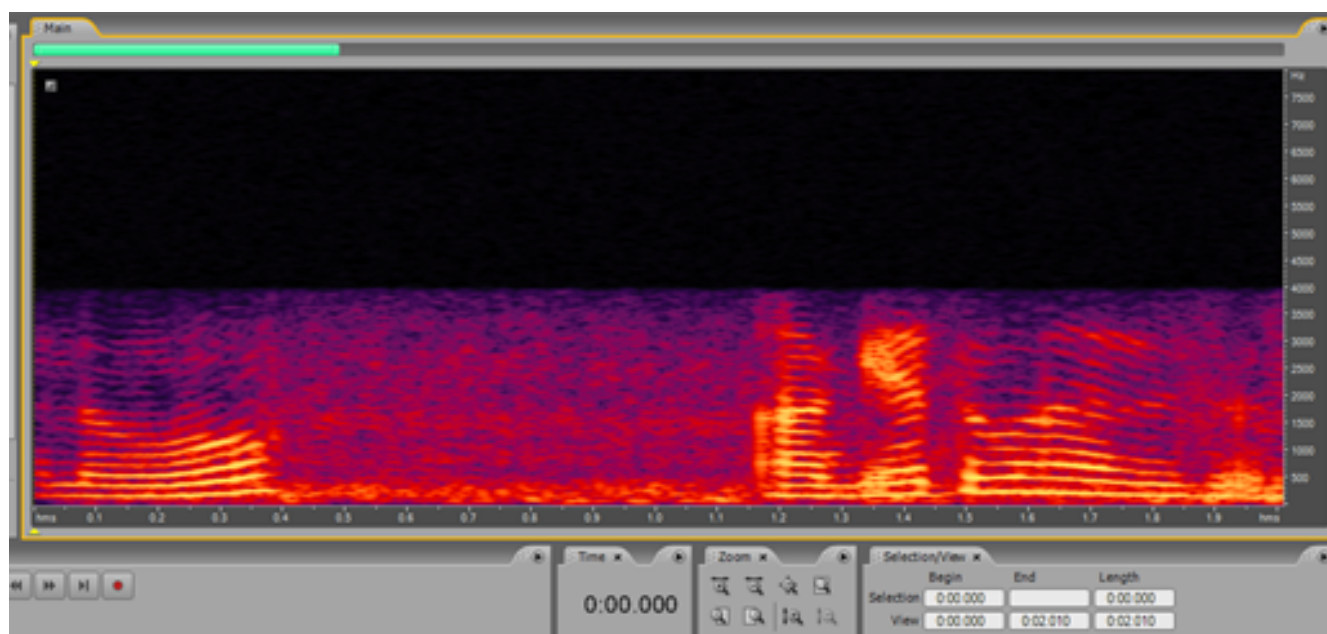

Fig 2. Pattern of input audio latency in MOTOROLA G4 PLUS mobile phone in 3gp format
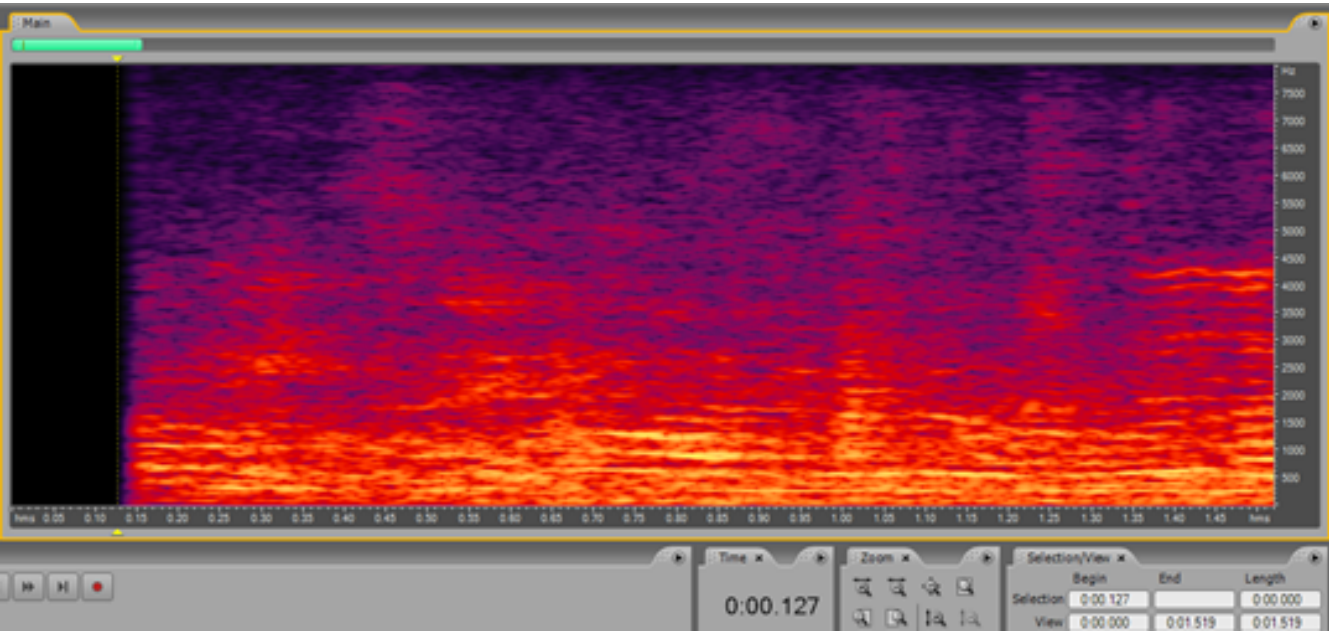
Fig 3. Pattern of input audio latency in SAMSUNG J5 prime mobile phone in wav format
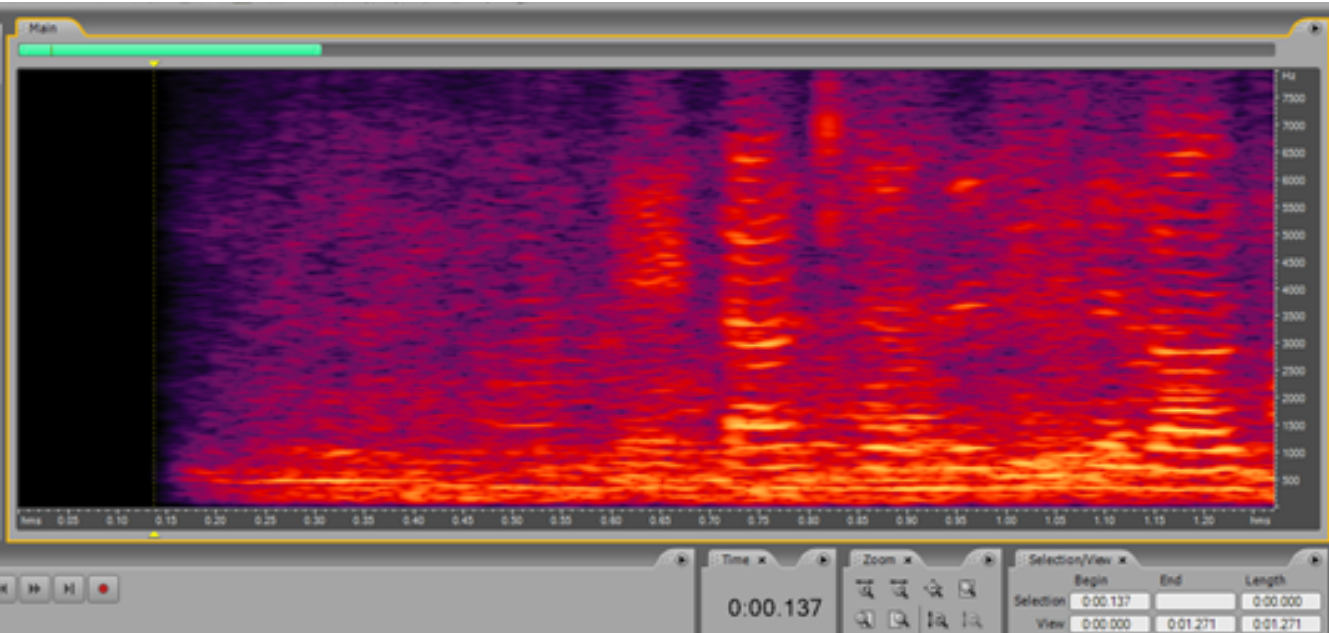

Fig 4. Pattern of input audio latency in SAMSUNG J5 prime mobile phone in 3gp format

4 Conclusion

In this comparative study, the conclusion we inferred that the mobile phones of SAMSUNG make shows a significant input latency time in both wav and 3gp format that lies in a specific range while mobile phone of Motorola make shows negligible input latency time in wav and 3gp format. Hence, the number of audio recording can be segregated on the basis of latency feature and we can identify its source in criminal investigation. The audio latency time feature is found to be an important feature in identifying the make of mobile phones in forensic science.

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