Reduction of Bumblebee Noise Generated by GSM

Han Su Kyi 1, Chaw Myat Nwe 2, and Hla Myo Tun 3

123 Department of Electronics Engineering
123 Mandalay Technological University

Abstract - This research work presents a method for reducing a bumblebee noise generated by a GSM system. Global smart phone penetration has been very swift and 2nd generation, 3rd generation and 4th generation communication technology are commercially used in the world. GSM technology uses a channel access method that combines frequency division multiple access (FDMA) and time division multiple access (TDMA). There are four commercial frequency bands. GSM technology has a burst structure by a TDMA method. And hence, the GSM technology has a disadvantage; radiation noise is generated from an antenna propagation signal of the smart phone, and consequently, the voice quality of the smart phone is degraded. This noise is commonly known as bumblebee noise, buzz noise or TDMA noise. There have been several studies to reduce the noise since a release of GSM technology in a commercial market. Those studies mainly focused on designing infinite impulse response (IIR) notch filters by the signal processing technology or on data burst transmission schemes.

Keywords – Reduction Algorithm, Bumblebee Noise, GSM, MATLAB, Digital Filter Design

I. INTRODUCTION

Smart phones can communicate using just one time slot out of the eight time slots. This is the burst structure of the GSM. That is, an antenna signal from the smart phone is propagated through air for only 0.577ms out of the total period of 4.615ms. Because of TDMA, the GSM technology has a disadvantage; radiation noise is generated from an antenna propagation signal of the smart phones, and consequently, the voice quality of the smart phones is degraded. This noise is commonly known as bumblebee noise or buzz noise.

Several studies were carried out to develop methods for reducing bumblebee noise. Those studies mainly focused on designing infinite impulse response (IIR) notch filters by the signal processing technology [1–4] or on data burst transmission schemes [5]. The first method needs more million instructions per second (MIPS) for operation, and hence, current consumption increases accordingly. The latter method requires a change in the protocol standard of the GSM; hence, its feasibility is low.

II. BUMBLEBEE NOISE

In Bees communicate with one another through a unique pattern of dance in order to pass on information about the availability of food (nectar) and when doing so, generate electromagnetic signals with a modulation frequency of 180-250Hz. Other bees in search of food react to such signals by erecting their antennae [6]. In the GSM, communication is established via the GSM burst structure. Noise is generated by the GSM burst. That is, smart phones send a burst of data to a base station every 4.615 ms, so that an audible 217Hz pulse waveform is generated. Because the frequency of the 217Hz pulse waveform is similar to the modulation frequency of the bee dance, this noise generated by the smart phone in the GSM is called as “bumblebee noise.” Because of the GSM burst, radio circuit of the smart phone is controlled by switching it on and off using the radio access rate frequency, and antenna signals are propagated with a frequency of 217Hz and its harmonics. An electromagnetic field fluctuating periodically at this fundamental frequency and its harmonics is coupled to a microphone signal from the smart phone and to signals from other electronic equipment, such as hands-free accessories, landlines, and radio, in the vicinity (within 1-2m) of the sending smart phone antenna.
Smart phones in the headset mode are specially affected by these frequencies during calls because the headset-wires play the role of a receiving antenna. The formula for the wavelength is written as
\[
\lambda = \frac{c}{f}, \quad (1)
\]
where
\[\lambda\] is the wavelength in meters,
\[f\] is frequency in cycles per second, and
\[c\] is the velocity of light (3.8 \times 10^8 m/s).

The optimum length required for an antenna to act as a monopole antenna is \(\lambda/4\) m. Thus, 11 and 5 cm long antennas are sufficient for the GSM850 and PCS1900 bands, respectively.

### III. IMPLEMENTATION

The overall flowchart is shown in Figure 1. The input “wav” file has to be analyzed based on the specified sampling frequency, sample time and length of the signal to response the noise signal and the spectrum of that noise signal can be displayed. And then these signals are passed through to the implemented IIR band pass filter and the noise reduction signal can be acquired. The developed system can be applied in real GSM system. The simulation results are shown in the following figures. In most of the previous studies, the problem of bumblebee noise was addressed by software-related changes. This study addresses the problem by designing band pass filters because if the processing time is miscalculated, software approaches can be ineffective in reducing the bumblebee noise.

**Start**

- Input “wav” file

**Sampling Frequency, Sample Time,**
**Length of Signal, Time Vector**

- Noise Signal and its Spectrum

- IIR Band Pass Filter

- Filtered Signal and its Spectrum

**Start**

*Figure 1. Overall Flowchart*

### IV. SIMULATION RESULTS

The simulation results are analyzed based on the specific parameter with MATLAB environments. Figure 2 shows the Bumblebee Noise at full rate (217KHz). Figure 3 gives the spectrum of Bumblebee Noise. Figure 4 demonstrates the input wave. Figure 5 mentions the spectrum of filtered signal. According to the simulation results, the reduction of Bumblebee noise generated by GSM technology has been accomplished to get the required specification.
Reduction of Bumblebee Noise Generated by GSM

Figure 2. Bumblebee Noise at Full Rate (217KHz)

Figure 3. Spectrum of Bumblebee Noise
Figure 4. Input Wave

Figure 5. Spectrum of Filtered Signal
Figure 6 shows the developed IIR band pass filter design. This design is constructed under the required specific parameters with the help of MATLAB.

IV. CONCLUSION

The headset of smart phones is used very frequently because of the impact of the specific absorption rate (SAR) by a smart phone antenna and the social etiquette regarding sound in public places. However, the headset is vulnerable to bumblebee noise in the GSM. Therefore, it is very important to design a method to reduce the bumblebee noise while the smart phone is in the headset mode during calls in the GSM. The simulation results have been verified by
experiments and it was found that, on an average the bumblebee noise was reduced up to specific noise in input signal.

REFERENCE