Energy consumption for Video Transmission in Mobile Ad Hoc Networks

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ABSTRACT

In the mobile ad hoc network the energy consumed by the transmitter and receiver is more significant due the more energy consumption in the transmitting and receiving of the data. Therefore energy consumption in the devices is needed to optimize. In this paper we analysis the Doppler shift effect on the energy consumption of the transmitter in video transmission over the mobile ad hoc network. In this work we analyses the energy consumption of the transmitter device over the MQAM modulation and vary the average velocity of the devices.

Keywords

Mobile Ad Hoc Network, MQAM, Doppler Effect, Energy Consumption,

1. INTRODUCTION

In recent development of communication, we have seen that wireless multimedia is growing rapidly. Due to this,need for number of mobile devices is also increasing.These mobile devices operate on the battery power. The battery power consumption affects the network connectivity and thus network life which have impact on video quality. Therefore, battery power consumption by these devices is of great concern to researchers due to the limited power supply [1, 2,3, 4,5]. Therefore, the minimization of battery power consumption is a key research area to enhance battery life and network life as well.

Video transmission in mobile ad hoc network has two major challenges for maintaining the minimum quality of service (QoS) requirements. One is to maintain the real time operation of video data and the other is minimizing power consumption by the mobile devices.There are many recent researches going on the energy saving like energy efficient routing [2, 3, 6, 7], energy aware scheduling of video, power consumption of the circuit of transmitter and receiver [1, 2,7, 8], etc. The mobile device comprises radio modem and data interface which are required for the communication [2,6, 9, 10]. During video transmission in mobile ad hoc network approximately 75% energy is consumed by the radio modem. Therefore, energy consumption by transmitter and receiver circuit is intensely considered by the researchers. In IEEE 208.11b wireless LAN card based on Intresil's PRISM II chipset, power amplifier (PA) consumes 600mW, 110mW by MAC processor, digital baseband consumes 170mW and 240mW consumed by the analog circuits [1, 2, 7,9].

2. RELATED WORK

Energy minimization is important goal for the video transmission in mobile ad hoc network. Due to the limited power of battery of the mobile node in the ad hoc network path failure occur. The path failure cause video distortion which affect the video quality [4,5,11].In video communication over mobile network, power consumption is of great concern. Significant power is consumed in transmission and receiving video packet by the mobile device circuits. In this most of the battery power consumed by the RF circuit. In the RF front, energy consumption model [1, 2, 3, 7, 9] consider physical layer parameters bit rate, bit error rate (BER), bandwidth, modulation, for optimization of the energy consumption in the transmitter and receiver circuit (RF). The other non-physical layer parameters like: thermal noise, fading, harmonic distortion also affect the energy consumption in the wireless communication [2, 3,7]. In thisenergy efficient video transmission schemesare developed that considersthe frame by frame, group of pictures (GOP)-GOP transmission and buffer related energy consumption.The client-buffer-related energy efficient video transmission (CBEVT) and smoothing strategy schemes reduce the power consumption in the video transmission. While CBEVT algorithm reduces energy consumption by sooner transmitting video data with the peak bit rate which frequently exceeds the transmission rate. This corresponds to the energy minimization at the modulation level. Smoothing algorithms optimize the energy consumption when buffer is large and average bit rate of video whichare close tothe energy minimization transmission rate [7].

The minimization of transmitter and receiver power for the video transmission requires minimizing the RF front-end power consumption. The standard transmitter and receiver block diagram is shown in figure1. It consists of digital to analog convertor, power amplifier, mixer, and RF synthesizer, different type of filters, noise amplifier and analog to digital convertor.

In this work we compute the power consumption of transceiver for the transmission of video packet. There are noise and other effects which have major impact on the power consumption. These effects are 1/f noise, harmonic distortion and Doppler Effect. 1/f noise occurs due the thermal noise, frequency dependency, and other factors. Harmonic distortion is caused by nonlinearity of the system.

Doppler shift is defined by the change or shift in the frequency due to the mobility of the transmitter and receiver devices in mobile ad hoc network [12]. If they are moving toward each other then frequency will increase and if they move far away from each other, then the frequency will be lower. Doppler shift f_d is given as

$$f_d = \frac{\upsilon}{\lambda}$$

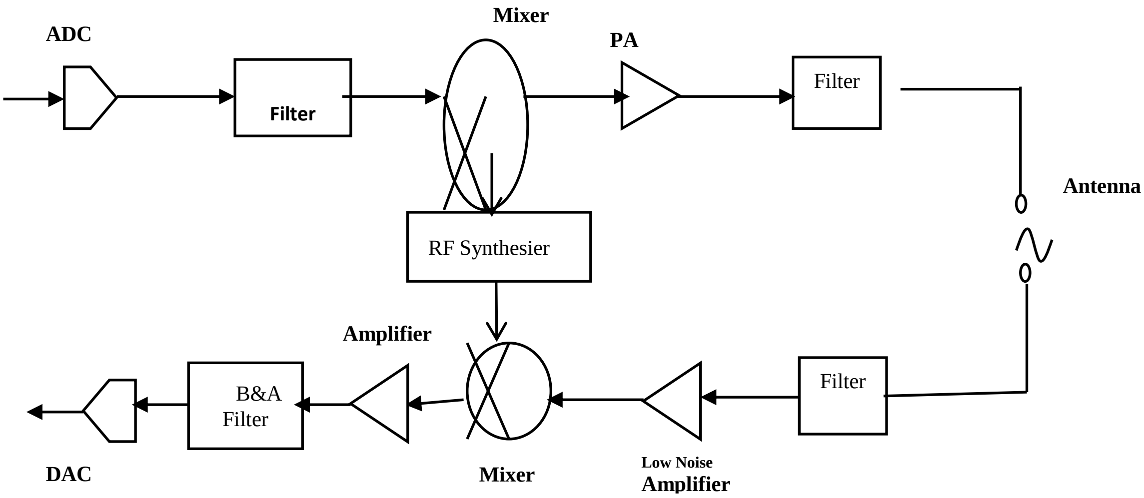

Fig1: Block diagram of transmitter and receiver system

3. PROPOSED WORK

Where ν is the average velocity of sender mobile devices and λ is the wavelength of the signal.

From the papers [7, 9] the ratio of the signal peak power to its rms value PAR is defined as $PAR(dB) = 10\log_{10}(P_{peak}/P_{rms})$. Where P_{peak}represent peak power and $P_{rms}$is average power. For the QAM modulation at the modulation level b, PAR is defined as

$$PAR_{QAM} = PAR_{modulation}(dB) + PAR_{roll-off}(dB) \tag{1}$$

$$PAR_{QAM} = \log\left(\sqrt{\frac{3.(2^{b/2}-1)}{2^{b/2}+1}}.PAR_c\right) + PAR_{roll-off}(dB) \tag{2}$$

Where PAR_c is the PAR of the carrier.

For the PSK modulation at modulation level b, PAR is defines as

$$PAR_{QAM} = \log(PAR_c) + PAR_{roll-off}(dB) \tag{3}$$

Power amplifier (PA) is the most power consuming part in the transmitter. For the different modulation power consumption in PA is describe as follows [2, 7, 9]

For the MQAM modulation

$$P_{PA(MQAM)} = \frac{P_{rms}}{R}\ .PAR \tag{4}$$

$$P_{PA(MQAM)} = \frac{16\,\pi^2.d^2.L}{3G_rG_t\lambda^2.K}(2^b-1).N.(Q^{-1}(\frac{1}{4}\left(1-\frac{1}{2^{b/2}}\right)^{-1} b.BER)^2)PAR_{QAM} \tag{5}$$

For the MPSK modulation

$$P_{PA(MPSK)} = \frac{4\,\pi^2.d^2.L}{G_rG_t\lambda^2.K}.N.(Q^{-1}(\frac{b}{2\sin\left(\frac{\pi}{2^{b+1}}\right)}.BER)^2)PAR_{PSK} \tag{6}$$

For the fading channel and Doppler Effect the power consumption will be changed therefore power is given as

$$P_{detected} = \frac{P_{rms}.|h|^2.G_rG_t\lambda'^2}{16\,\pi^2.d^2.L} \qquad ,h\ is\ fading\ factor \tag{7}$$

Power consumption in PA for the fading channel and Doppler Effect in MQAM modulation

$$P_{PA(MQAM)} = \frac{16\,\pi^2.d^2.L}{3G_rG_t\lambda'^2.|h|^2.K}(2^b-1).N.(Q^{-1}(\frac{1}{4}\left(1-\frac{1}{2^{b/2}}\right)^{-1} b.BER)^2)PAR_{QAM} \tag{8}$$

Power consumption in PA for the fading channel and Doppler Effect in MPSK modulation

$$P_{PA(MPSK)} = \frac{4\,\pi^2.d^2.L}{G_rG_t\lambda'^2.|h|^2.K}.N.(Q^{-1}(\frac{b}{2\sin\left(\frac{\pi}{2^{b+1}}\right)}.BER)^2)PAR_{PSK} \tag{9}$$

For the transmission of the video data the energy consume by the PA for per bit is defined as followsfor MQAM and MPSK modulation

$$E_{bit\_PA} = {P_{PA}}/{b.R_s} \tag{10}$$

In the PA significant amount of energy is consumed for the transmission and other parameters also affect the energy consumption in RF circuit. Energy consumed by the RF front end can be expressed as

$$E_{bit} = \frac{P_E+P_{PA}}{b.R_s} \tag{11}$$

Energy consumption for the QAM modulation

$$E_{bit} = \frac{P_E}{b.R_s} + \frac{16\,\pi^2.d^2.L}{3G_rG_t\lambda'^2.|h|^2.K}(2^b-1).\frac{N}{b.R_s}.(Q^{-1}(\frac{1}{4}\left(1-\frac{1}{2^{b/2}}\right)^{-1} b.BER)^2)PAR_{QAM} \tag{12}$$

Energy consumption for the PSK modulation

$$E_{bit} = \frac{P_E}{b.R_s} + \frac{4\,\pi^2.d^2.L}{3G_rG_t\lambda'^2.|h|^2.K}.\frac{N}{b.R_s}.(Q^{-1}(\frac{b}{2\sin\left(\frac{\pi}{2^{b+1}}\right)}.BER)^2)PAR_{PSK} \tag{13}$$

4. RESULT ANALYSIS

We analyses the Doppler Effect on the energy consumption in video transmission over ad hoc network. Figure 2 &3 (a), (b), (c), (d) and (5) represent the energy consumption according to BER for 4QAM, 8QAM, 16QAM, 32QAM, 64QAM respectively. In figure 2 energy consumption and BER performance when average velocity of mobiledevices is 4km/h is shown. Figure 3 shows the performance at average velocity of 40km/h for the mobile nodes.For QAM modulation higher is the modulation level, lower is the energy consumption.The graphs of figure 2 and 3 show that as modulation level increases, the transmission energy consumption decreases. Therefore, for the higher QAM modulation, energy consumption is lower.

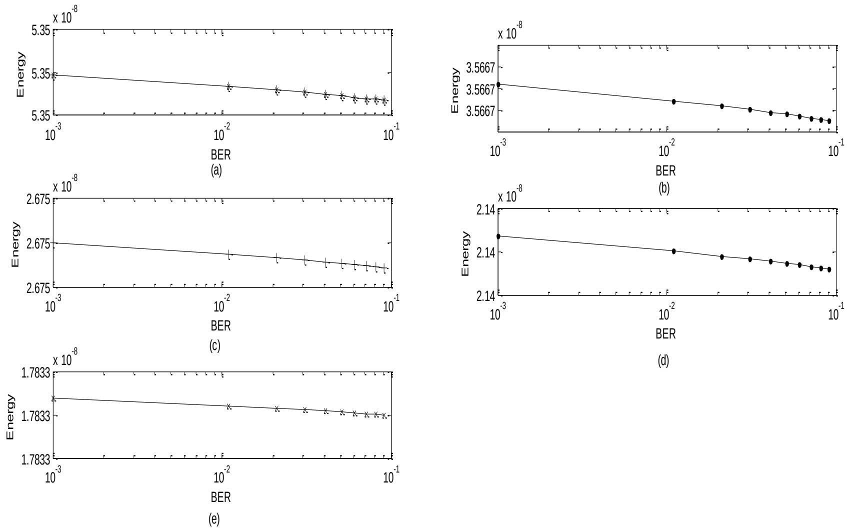

Fig 2: Energy Consumption at average velocity of 4Km/h of the mobile nodes

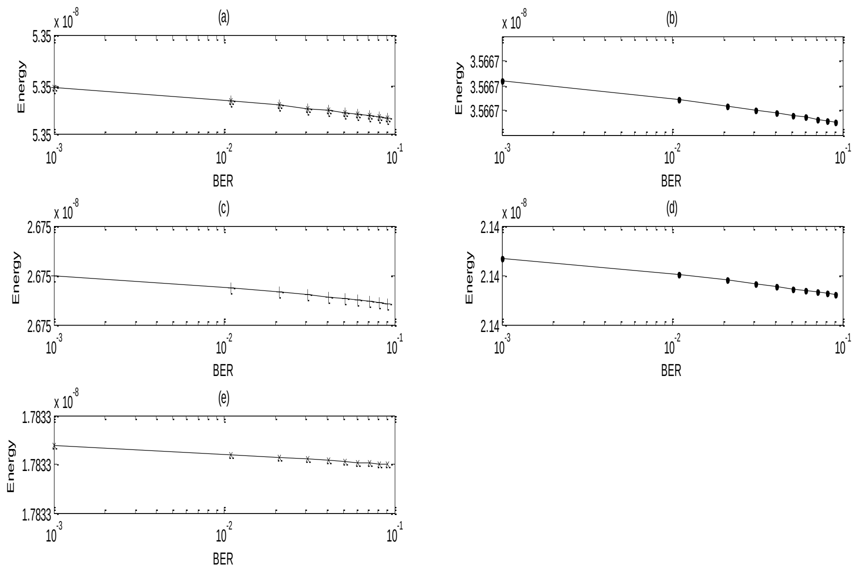

Fig 3: Energy Consumption at average velocity of 40Km/h of the mobile nodes

5. CONCLUSION

In this work, we analyzed the effect of Doppler shift in energy consumption by video data transmission over ad hoc network under different average velocity of the devices. It is observed that the effect of energy consumption is very less at the different average velocity of the devices. But for the higher level of modulation energy consumption is lower due the Doppler shift in the network.

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