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Effect of Using Different Encoders in Bluetooth

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Abstract- IEEE 802.11 and Bluetooth are the two different wireless systems that share the same frequency band in 2.4 GHz and are likely to interfere with each other if operating in the same environment and thus experience a severe decrease in throughput. The devices equipped with IEEE 802.11 and Bluetooth are mobiles, laptops, watches and many more and in future with WiMAX. Result is the number of co-located devices may cause interference issues in the 2.4 GHz radio frequency spectrum. Like other communication devices Bluetooth also consists of transmitter, channel and receiver. In transmitter and receiver encoders and decoders are used. In Bluetooth transmitter different types of encoders are used like RS encoder, Hamming encoder, CVSD encoder etc. these encoders have its own advantages and disadvantages. In this paper, by using of two different encoders like hamming encoder and CVSD encoder we analyse the communication of Bluetooth device and compare the BER.

Keywords-CVSD, ISM, LMP, L2CAP, HCL, PCM and RFCOMM

I. INTRODUCTION

A. Bluetooth

Bluetooth technology is a short-range technology that is simple and secure. It is replacing the connecting devices containing cables and maintains
high level of security. The key features of Bluetooth technology are low power, robustness, and low cost. Two Bluetooth enabled devices connecting each other is called pairing. It is an operation on unlicensed industrial, scientific and medical (ISM) band at 2.4 to 2.48GHz, using a frequency hopping, spread spectrum, full-duplex signal up to 1600 hops/sec. The signal hops among 79 frequencies at 1MHz. The Bluetooth Specification defines a short range (10 meter) or a medium range (100 meter) radio link that is capable of data or voice transmission to a maximum capacity of 720 kbps per channel.

B. Ad-hoc networking

Point-to-point and point-to-multi-point connections are being supported by Bluetooth. Point-to-point or peer-to-peer means when only two terminals are connected. Multi point connection means when more than two terminals are connected to each other.

1. Piconet

There is a maximum limit of 8 devices in this configuration, one master and seven slaves.

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The master controls traffic and access to the piconet. If one slave wants to connect to another, it must take permission from the master. Nearly, 255 devices can be virtually connected to the piconet.

2. Scatternet

Multiple piconets can be connected to form a scatternet. In this configuration each piconet is identified by its individual frequency hopping sequence. A device can participate in different piconets but can only be active in one at a time.

C. Operating modes of bluetooth

Bluetooth has several modes to search other terminals that are as follow [4]:

Standby: Devices not connected in a piconet are in standby mode. In this mode, they listen for messages every 1.28 seconds over 32 hop frequencies.

Page/Inquiry: If a device wishes to make a connection with another device, it sends out a page message, if the address is known, or an inquiry followed by a page message.

Active: Data transmission occurs.

Hold: When either the master or slave wishes, a hold mode can be established, during which no data is transmitted.

Sniff: The sniff mode, applicable only to slave units, though not at as reduced a level as hold. During this mode, the slave does not take an active role in the piconet, but listens at a reduced level.

Park: Park mode is a more reduced level of activity than the hold mode. During it, the slave is synchronized to the piconet, thus not requiring full reactivation, but is not part of the traffic.

II. DIFFERENT ENCODERS OF BLUETOOTH

A. Shortened hamming encoder

Hamming Encoder creates a hamming code with message length K and code word length N. The number N must have the form 2M-1, where M is an integer greater than or equal to 3. Then K equals (N-M)**.** This block accepts a column vector input signal of length K. The output signal is a column vector of length N. A shortened Hamming code of length 2m−1−s is a (2m−1−m−s)-dimensional subspace of the (2m−1−m)-dimensional space constituting the canonical Hamming code. This subspace is usually obtained by setting a fixed number s of data bit positions to 0. Commonly, for ease of implementation, the first s data bit positions are set to 0. The transmitted code word is also shorter by s positions because the first s bits of each (canonical Hamming) code word are not transmitted. Since the encoder and decoder are designed by a common intelligence, there is no need to transmit the s leading zeroes in each code word;

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the decoder can always insert them at the beginning of each received word if it needs them in order to carry out the decoding algorithm. In fact, let us assume for convenience that the decoder inserts the missing zeroes at the beginning of each code word and then executes the canonical Hamming code decoding algorithm. If zero or one of the transmitted bits in a code word from a shortened Hamming code is received in error, the decoder will decode correctly, complementing the bit, if any, that is in error.

If more than one transmission error has occurred, then there are two possibilities to be considered; changing one bit in the received 2m−1−s bits maps y into a code word z in the shortened code. This is a decoding error, just as with the canonical Hamming code and changing one bit in the prepended s zero bits would change 000⋯0z into a code word 00⋯010⋯0y in the canonical Hamming code. Since these s bits must be 0, the decoder concludes that an un-decidable error pattern occurred in the 2m−1−s bits that were actually transmitted, and this information can be passed on to the end user.

B. CVSD encoder

Two speech encoders are specified in the standard: Continuous Variable Slope Decoding (CVSD) and 64kbps log PCM. Such schemes are very robust to bit errors. If a bit is corrupted while transmitting, then the decoded speech at the receiver will only be in error by a small fraction. CVSD is a linear delta modulation with the addition of an adaptive step-size. By adjusting or adapting the step-size to the changes in slope of the input signal, the encoder is able to represent low-frequency signals with greater accuracy without sacrificing as much performance due to slope overload at higher frequencies. When the slope of the input signal changes too quickly for the encoder to keep up with it, the step-size is increased. Conversely, when the input signal slope changes slowly, the step-size is decreased. The encoder maintains a reference sample and a step size. Each input sample is compared to the reference sample. If the input sample is larger, the encoder emits a 1 bit and adds the step size to the reference sample. If the input sample is smaller, the encoder emits a 0 bit and subtracts the step size from the reference sample.

III. SIMULATIONS

A. Bluetooth model with hamming encoder and decoder

In this model, binary generator is used for input. Shortened hamming encoder whose code word length is 15 and its message length is [1 1 0 1 0 1] is used for encode the data. For assemble the data we use buffer it assembles 625 bits at rate of 1Mbps. For modulation GFSK modulation is used where CPM and M-ary FSK modulation is used in which one input is data from buffer and another is from hopping sequence generator. For channel AWGN channel is used for transmission in which initial seed is 1 and signal to noise ratio is 20. For demodulation M-ary FSK is used. Dis-assembler is also used for un-buffer the data. Through hamming decoder the data goes to receiver end.

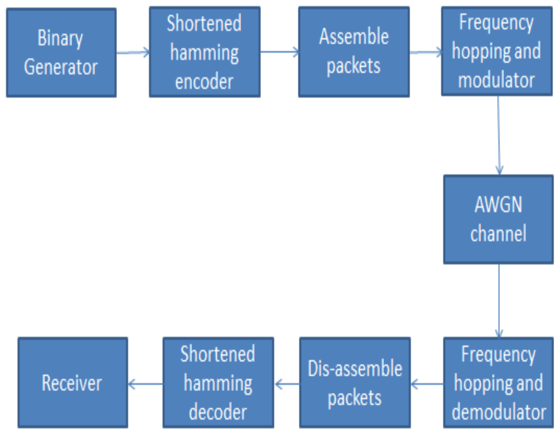

Figure1-Bluetooth model with hamming encoder-decoder

B. Bluetooth model with CVSD encoder and decoder

For input wave file is used whose sample rate is 8000Hz. The up-sample is used for sampling the data at rate of 64kbps. Then CVSD encoder is used which encode a 64 K samples per sec speech signal into a 64Kbps bit stream. CVSD encoder whose minimum step size is 10 and maximum step size is 1280. Buffer is used to assemble the data. Modulation is same as previous case. For transmission AWGN channel is used with rand seed 2. In CVSD decoder accumulator decay is 1-1/32 and step decay is 1-1/1024. Un-buffer is used before the CVSD decoder. After CVSD decoder down sampler is used to convert the data back to 8000Hz.

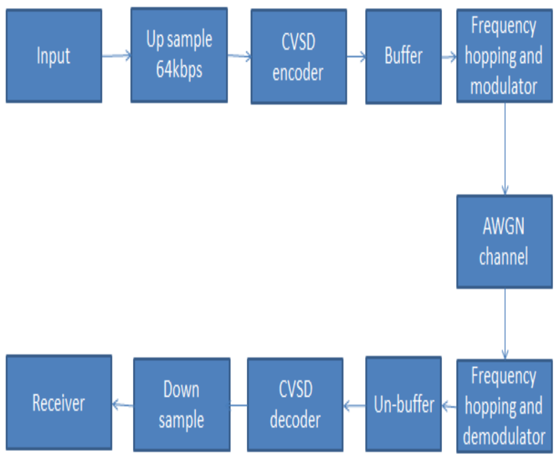

Figure2-Bluetooth model with CVSD encoder-decoder

IV. RESULTS AND CONCLUSION

A. When hamming encoder is used

Hamming encoder whose code word length is 15 is used. Hamming encoder encodes the binary data only. In hamming encoder the first s data bit positions are set to 0. The transmitted code word is also shorter by s positions because the first s bits of each code word are not transmitted. But in hamming encoder or decoder voice signal cannot be processed.

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When we use GFSK modulator with Hamming encoder the encoded waveform changes as shown in figure 3 and it varies through frame to frame with different frequency hopping.

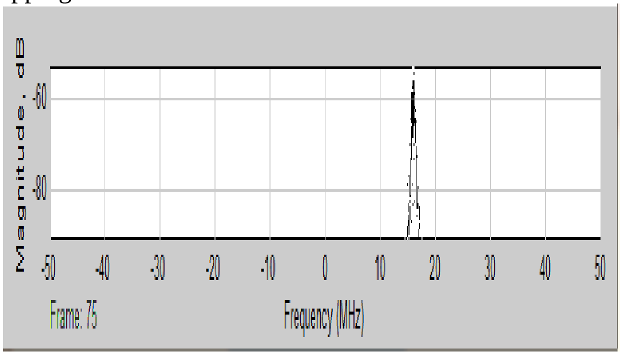

Figure3- after modulation transmitted signal

B. When CVSD encoder is used

Continuous Variable Slope Decoding (CVSD) is very robust to bit errors. CVSD is linear delta modulation with the addition of an adaptive step-size. By adjusting or adapting the step-size to the changes in slope of the input signal, the encoder is able to represent low-frequency signals with greater accuracy without sacrificing as much performance due to slope overload at higher frequencies. CVSD encoder is also used for higher frequencies as well as for high power levels. In CVSD encoder, we can use different HV1, HV2 and HV3 for voice signal.

When we use GFSK modulator with CVSD encoder the encoded waveform changes as shown in figure 4 and it also varies through frame to frame with different frequency hopping.

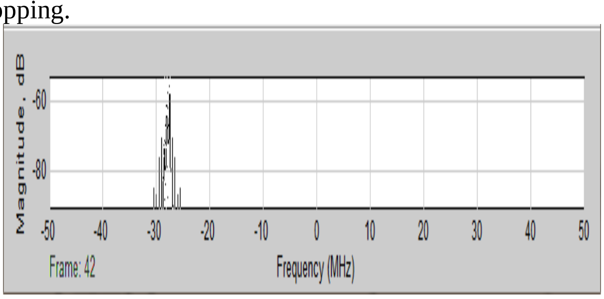

Figure4- after modulation transmitted signal

C. Conclusion

From above discussion we can easily say that CVSD encoder is far better than Hamming encoder. The simulation of Bluetooth is done in Matlab and bit error rate is good in CVSD encoder. Hamming encoder is used earlier when Bluetooth 1.0 and 2.0 is used after 2.1 to till 4.0 CVSD encoder is used due to good result in efficiency, bit error rate and more number of bits are travelling due to CVSD encoder.

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