Implementation of FHMA Communication System using LabView


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ABSTRACT

This research was conducted FHMA (Frequency Hopping Multiple Access) standard using Labview. FHMA was developed in Israel in the spectral efficiency. The main objective of this research is to emphasize the performance of the communication system of FHMA paper. FHMA have good radio features that provide full radio capacity, covering the trunking and untargeted mobile phone, with a choice of services including packet mode, short message services and voice. FHMA is compatible with a wide range of additional services, and can be used as for government, emergency services, transportation and military applications.

Keywords: BER, Labview, SQPSK, TDMA.

1 INTRODUCTION

FHMA is a digital multiple access communication system where the frequencies of the carrier are different from the broadband subscribers in a pseudo-random channel. FHMA allow different users to use concurrently the similar range at the same time, where every user use a particular narrow band channel time demanding. For example depends on the required user PN code. Digital data from each user is divided into bursts in the same size, which are sent in different channels within the define range. The burst of any transmission is smaller than the size of the increase in bandwidth. Pseudo-random frequencies to randomly change the user choose to use a particular channel every time, allow multiple access via a large range of frequencies. PN code is used to match the direct frequency of FH transceiver to receiver.

A frequency hopped signal occupies only one comparatively narrow channel because the narrowband FM/FSK is used. The difference between the FHMA and current FDMA system is the fact that the signal changes the frequency of channels in short intervals. Frequency hopping any system depends on the rate of change of the symbol rate of the carrier frequency. A system in which carrier frequency rate is higher than the symbol rate that system is called fast frequency hopping system. A system in which the carrier frequency rate is less than (or equal) to the symbol rate that system is called a frequency hopping system. Fast frequency hopper can be seen as FDMA which uses the frequency range. Systems frequently use FHMA competent energy modulation standard package. The preferred receptors can be constructed to provide a non-coherent detection FHMA. This means that the linearity is not a problem, a number of users and the power at the receiver does not harm for FHMA efficiency.

To provide a security huge number of channels are used in frequency hopped system since the cut-receiver who does not know the frequency of the output is pseudorandom RIT quickly find the signal you want to hear. Furthermore, FH signal is relatively resistant to loss as interleaving and error control coding can be used for the protection of deep fades in frequency hopped signal, which might happen rarely during hopping sequence. Deinter leaving and error control coding methods are collectively used for protection against scratching, which can occur when two or more than two users transmit through same channel at the same time [8].
In systems FHMA PAMR market, especially to try to deal with the challenge of commercial users. Spread spectrum multiple access (SSMA) techniques are resistant to natural properties (typical multipath signals and aggressive disorders), and received an increasing interest in commercial wireless communications. Frequency hopping multiple accesses (FHMA) in Wireless broadband multimedia communications is an attractive candidate camper are SSMA techniques [1].

In FHMA systems due to the use of the same frequency synchronized to the gap may interfere with the signal transmitted by the other signals, called case shit. Hit events that are directly related to the numbers in synchronized users and the frequency of the output of the system. To reduce the impact of events to increase the efficiency of the modulation frequency to increase the amount of loss can be limited bandwidth efficiency of the system [2].

2 TECHNICAL OVERVIEW

FHMA is mainly grown on digital radio technology that produces the best supernatural efficient mobile communication system. The basic solution of communication is a combination FHMA (CDMA method) and TDMA (3:01). Powerful guard collectively error codes with interleaving conditions offer significant safety channels, either next to the depreciation of weak signal strength or received nosiness.

To run mobile phone in interfering channel hopping parameters be selected to attain the intention of high spectral efficiency. The physical layer hardness of FHMA technology is used to improve the ability to implement a cellular reuse outline by a low frequency reuse factor. The trading system allows reuse of the capacity and vice versa, FHMA defines control channels (two-way) and an air interface traffic channels of which only the traffic channels are hopping.

2.1 FHMA Services

FHMA system was introduced for PAMR users. Users that are required the doable community use this service. Moreover, unique applications were introduce for particular users, mainly data applications as shipment data ("Manifesto") and automatic vehicle location surrounded (AVL).

Seek to define the applications and services, for example mobile fleets are used to give the Community with all their control needs and interactions with in a one system. This include Voice transmit mode (group and individual), bearer services, telephony and information for precise applications (e.g. Manifest, AVL). There are three main services FHMA [7].

2.1.1 Offered Services

The offered services are sub-divided into following services which are illustrated bellow.

2.1.1.1 Teleservices

Teleservices are used to provide fundamental communications and applications such as: the mobile to mobile phone, send (trunked), selective access to the services, speech communications, mobile phone group voice communication (trunked), fax, including the option for secure communication (mainly user furnished algorithms), telephone between the PSTN and the mobile station , data applications, such as data-transfer mode ( groups and individuals), 2-way side, text messaging, and automatic vehicle location (based on GPS).

2.1.1.2 Bearer Services

The Packet scale data and connection less sloping provides the nominal bit rate 4.8Kbit / s protected data, 9.6 Kbit / s data for insecure and 2.4 Kbit/s (or 1.2 Kbit/s) for strongly protected data. For more information multisolt it gives a bit rate 28.8Kbit/s unprotected and 14.4 Kbit/s for protected data.

2.1.1.3 Supplementary Services

These services are the expansion of the newly offered and which can be implemented fulfilling the classic PMR (Public Mobile Radio).

2.1.2 Voice Services

The voice services are sub-divided into following services which are described below.

2.1.2.1 Telephony

It provides full duplex telephone service. Transcoding make calls only for PSTN subscribers. Its unruffled noise rate 4.4 kbit/s for vocoder and 2.4 /5.55 kbit/s optional.

2.1.2.2 Group Transmit

The group sends the service we have three types of group requires difficult group call, the group accepted a call and send a voice message. In severe group call hard to multi-point system TCH only one call at a time, and the owner of the pre-televisioned group. The member of Group call might be roam between service areas.
PPT response of unacknowledged group call time is 500ms. Approved group call and unacknowledged group call is similar however the caller may get a existence list during call initiation possibly to on later. In an audio message broadcast thankless one way to multi-point system calls with the TCH start MS or LS unit.

2.1.2.3 One to One Dispatch (121)

It is a Semi-duplex bidirectional point-to-point process. It is used for meeting leaning with suspended timer and handshaking in band over the traffic channel. Switching controller (CC) solve contention. Its call setup time is 500 ms.

2.1.3 Data Services

Information services are divided into the following services, which are described below:

PM (packet mode) connection oriented data:
- It is ordinary (TCP/IP) connection-oriented service.
- It used following bit rate for the service like 9.6 Kbit/s for insecure, 4.8Kbit/s for nominal protected and 2.4, 1.2 Kbit/s heavy protections.

2.1.3.1 Packet Mode Connection-less Data

It is a (UDP/IP) protocol that used in shared channels (statistical multiplexing). Its bit rate is same as packet mode connection-oriented data. It is also provide the Direct Internet connectivity.

2.1.3.2 Short Message Service

The basic units of Short message are 96 bytes with practically message length. It is used for both Point-to-point and point-to-multipoint communica-

2.1.3.3 High Speed Data Service

It supplies data for up to three slots in TDMA and televese the connection is secure bit rate of 14.4 Kbit/s and 28.8Kbit/s for unprotected in network application services.

FHMA provides standard TCP/IP services based following network application services such as special data message, a forward and store messaging service, modem and AVL. A forward and store messaging service provides to the users and extra message handling services for example group (GDM) and character (IDM) messages, registered and unique release messages. To access these services we use special and communications APIs. For example, a modem (Hayes compatible) communications service (PCCA / AT), which allow users to use commands standard communication Modem (AT / PCCA).AVL convoy executive GPS based management (Etak PC application) consecutively in the subscriber unit (SU) lease line and PSTN access.

2.2 FHMA Interfaces

Three types of interfaces are accurate in FHMA communication intersystem signaling, service interworking and line-station interface. Intersystem signaling accurate due to SS7MAP (IS-41C) and service interworking accurate due to distributed connectivity towards PSTN, ISDN and internet. Where a line-station interface accurate due to standard connectivity towards integrated packet handler (DC).

2.3 FHMA Uses

Frequency hopping (FH) communication systems have been used in the widespread use of satellite and military applications in the country, take advantage of low power spectral density [6]. In addition, FH communications systems have become more common these days for commercial applications license-free industrial, scientific and medical (ISM) bands [3]. Commercial applications, multiple access has been a key, so that the frequency of multiple hops Multiple Access (FHMA) systems have been proposed [4] - [5]. Bluetooth and Home RF FHMA have wireless technology for energy efficiency and cost-effective implementation.

3 Simulation Model and Results

FHMA system is implemented in Labview. Labview have large libraries with a large amount of functions for data accomplishment, signal creation, statistics, mathematics, signal conditioning, and study. FHMA basic block are described below:

3.1 Transmitter

Transmitter for FHMA System is shown in Fig.1:
3.1.1 Generation of Message Bits

The small portions of message bits are used as a reference shown in Figure 2. Here we use a group. This group is a “MESSAGE”. The elements of that group are Guard bits, Number of bits and Sync bits. This group generates the GEN BITS in Sub VI which are shown in Fig. 2:

Table 1: Parameter of Message Signal

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Guard bits</td>
<td>2</td>
</tr>
<tr>
<td>Number of Sync Bits</td>
<td>20</td>
</tr>
<tr>
<td>Number Of Bits</td>
<td>More than 500</td>
</tr>
</tbody>
</table>

3.1.2 Channel Coding

Channel coder convert our massage in the form of 10010010... and shuffled them (to avoid the large effect of noise). The bit sequence of the input bit stream that come from message bit generation specifies the data word for encoding. Generation of encoded bits stream depends on the specified code rate. This code rate is equal to the ratio between the code word length and data word length. The efficiency of the code measure by the Code rate k/n of channel, n and k shows the number of output and input bits respectively. The values of code rate k/n and constraint length L = k...
(m-1), m is the number of memory registers shown in Table-2. The length (constraint) communicate to the number of bits present in the encoder that have an effect on the formation of n output bits.

Table 2: Convolution Parameters (Encoder/Decoder)

<table>
<thead>
<tr>
<th>Constraint length “k”</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate “k/n”</td>
<td>1/3</td>
</tr>
</tbody>
</table>

The encoded bits are shown in Fig.3 these bits are labeled "Transmit sequence block", where the guard bits and bits attached to the synchronization.

3.1.3 Modulator

Modulator converts the output bit stream of the channel coder into complex wave form. The bits which are emit from the channel coding enter into the modulator, thus send message via a channel. \(\Pi/4\)SQPSK is the modulation scheme of FHMA. Some parameters of modulator are pulse shaping filter parameter is Raised cosine filter, synchronization parameter is set and modulation parameter is PSK. PSK system parameters are used to define the parameter PSK system. In Sync parameter of PSK type used is ‘offset’ as shown in the Figure:

Table 3: \(\Pi/4\)SQPSK (Modulation/Demodulation) Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>PSK</td>
</tr>
<tr>
<td>M-PSK</td>
<td>4</td>
</tr>
<tr>
<td>Alpha</td>
<td>0.8</td>
</tr>
<tr>
<td>Filter Length</td>
<td>8</td>
</tr>
<tr>
<td>Tx filter</td>
<td>None</td>
</tr>
<tr>
<td>Differential PSK</td>
<td>Disable</td>
</tr>
<tr>
<td>PSK Type</td>
<td>Offset</td>
</tr>
</tbody>
</table>

The constellation diagram of FHMA modulator is given below:

3.2 Channel

Channel is the backbone of the system. The output of modulator (which are complex wave form) passes through the channel. Here we used Additive White Gaussian Noise (AWGN) block as a channel. The parameter of AWGN block is bit per symbols, samples per symbols and SNR (Eb/N0). The value of that parameter is shown in Table-4. The \(\text{SNR (signal-to-noise)}\) ratio specifies the preferred Eb/N0 of the output waveform in unit of dB.

Table 4: channel impairments

<table>
<thead>
<tr>
<th>Bit per Symbols</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samples per Symbols</td>
<td>16</td>
</tr>
<tr>
<td>Eb/No</td>
<td>10-15db</td>
</tr>
</tbody>
</table>

The constellation diagram of FHMA modulator is given below:
3.3 Receiver

Fig. 7 shows the Implementation of Receiver for FHMA in Labview:

![Fig. 7 Receiver](image)

3.2.1 Demodulator (π/4 SQPSK)

The π/4 SQPSK demodulator demodulate the complex baseband waveform that receive from the channel and returns the bit stream that oversampled complex waveform,. The values of the parameters of the π/4 SQPSK demodulator is same as define in modulator to get the same output. The demodulated receiver bits are shown in Fig. 8:

![Fig. 8 Demodulated Bits of π/4SQPSK Demodulator](image)

3.2.2 Channel Decoder

Channel decoder use a specified code rate to decodes a encoded bit stream. The code rate of channel decoder is same as define in channel coding. The decoder is reshuffled the input bit stream came from demodulator and then convert into specifies the bit sequence. The decoded recovered message bits are shown in Fig. 9:

![Fig. 9 Decoded Bits](image)
3.4 Simulation Results

In Fig. 10, we can see the message bits, recovered bits, transmitted bits, received bits and encoded bit streams. Constellation graph, BER, Samples per symbol and Eb/N0 as we can examine the result by comparing the transmitted and received message bits, by checking the BER and also considering the constellation graph. Here the transmitted bits and received message bits are equal; we can say that FHMA System is working properly. The constellation diagram indicates the modulation scheme being used.

![Simulation Results for FHMA](image)

In Figure, it can be seen that the BER is also 0 which indicates that all the bits transmitted have been received correctly. Also it can be seen that the message bits are same as the recovered bits, showing that system is working properly.

5 CONCLUSION

Prime objective of this research is implementation of FHMA communication system in a unique environment like LABVIEW. we see that in FHMA communication system Bit Error Rate is zero that proves the excellent performance of FHMA in noisy environment. After these results we can say that the FHMA is an excellent choice of error free communication and better quality of service with complete security. Features that make FHMA are well suited to modern communication are: phones, very clear digital voice, seamless roaming, personal phone calls, group calls, fast call set up times, interoperability of devices, direct mode communication, privacy and security.

6 REFERENCES


[2] Ing-Jiunn Su and Jing Shown Wu "Performance comparison of MFSK frequency-hopped multiple access systems
with rtt decision over a rayleigh fading channel" Department of Electrical Engineering National Taiwan University Taipei, Taiwan 106, R.O.C.


