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Design and Implementation of DS-CDMA on TMS320C6713 DSP Kit

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ABSTRACT:

This paper describes how DS-CDMA (Direct Sequence-Code Division Multiple Access) technique in CDMA communication system is used and how it can be implemented on a DSP Starter Kit Board. Walsh Hadamard orthogonal codes are used as orthogonal code words. DSK (Dsp Starter Kit – TMS320C6713) along with Code Composer Studio V3.1 is used to simulate the whole process. Voice input (or Digital Data) is taken as information, which is broken as packets and transmitted using CDMA technique, the received data is Decoded and played back. An eight User Code Division Multiple Access Technique is designed, which can be easily extended to multiple users. The spreading factor of eight is implemented, which is depended on size of Walsh Hadamard Matrix.

INDEX TERMS:

CDMA, DS, Orthogonal Codes, Spreading, TMSC6713, Walsh Hadamard.

I. INTRODUCTION:

CDMA(code division multiple access) Technique is used widely in wireless communications to support the increasing growth of telecom users. The possible way of multiplexing multiple are Time division multiplexing, Frequency division multiplexing, Space division multiplexing, direct sequence multiplexing[1].Code Division Multiple Access (CDMA) has become the technology of choice for the current and future generation of wireless systems. CDMA system allocates all resources to all active users. In direct sequence (DS) CDMA systems, the narrowband message signal is multiplied by a very large-bandwidth signal called the spreading signal[8], which increases the bandwidth of the complete signal, and adds encryption to signal.

All users in a DS CDMA system use the same carrier frequency and may transmit simultaneously. Each user has its own spreading signal, which is approximately orthogonal to the spreading signals of all other users. Which is a necessary condition for CDMA to work. At the receiver it performs a correlation operation to detect the message addressed to a given user. The signals from other users appear as noise due to decorrelation. For detecting the message signal, the receiver requires the spreading signal used by the transmitter[2].

Each user operates independently with no knowledge of the other users. There by making the users to enter and leave the network without interfering with other users. CDMA has an inbuilt feature of encoding or encryption, it does scrambling at a rate greater than data rate. The signal to intruder looks like a static noise, as CDMA uses power levels in range of noise, making it very hard to detect to a intruder.

This paper is organised as follows. In section 2 The Process of CDMA is explained, section 3 deals with how CDMA is performed on TMS320C6713 , The Results and Conclusion are discussed in section4.

II. CDMA STEPS FOR MULTIPLE USER:

Data for transmission is combined via bitwise XOR (exclusive OR) with the faster code,(Walsh Hadamard used here). The data signal with pulse duration of Tb (symbol period) is XOR'ed with the code signal with pulse duration of Tc (chip period). Therefore, the bandwidth of the data signal is 1/Tb and the bandwidth of the spread spectrum signal is 1/Tc .The ratio Tb/Tc is called the spreading factor or processing gain and determines to a certain extent the upper limit of the total number of users supported simultaneously by a base station[4].If Tb=Tc It becomes a scrambling technique.

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In this project, we use Walsh Hadamard codes as orthogonal codes . In particular, the Walsh-Hadamard codes of length N can be defined from the following recurrent ruleOrthogonality is the most important property of Hadamard-Walsh codes. Because of this orthogonality property, the cross-correlation between any two Hadamard-Walsh codes of the same set (matrix) is zero, when system is perfectly synchronized [7].

Walsh codes are not maximal length or PN type codes for spread spectrum. Although the members of the set are orthogonal, they do not give any spreading. They are used in forward channel of IS-95 CDMA type system for their orthogonality.

CDMA2000 versions use codes generated by LFSR(Linear Feedback Shift Register) which are not perfectly orthogonal but can be used for asynchronous CDMA, Gold Codes that are a class of Pseudo Random codes as orthogonal codes, which are used in asynchronous CDMA.

III. CDMA ON TMS320C6713:

Digital signal processors, such as the TMS320 family of processors are used in a wide range of applications, such as in communications, controls, speech processing, and so on[6].Texas Instruments introduced the TM320C6x processor, based on the very-long instruction-word (VLIW)architecture. The DSK package is powerful, yet relatively inexpensive, with the necessary hardware and software support tools for real-time signal processing.

The DSK board, with an approximate size of 5 x 8 inch, includes the C6713 floating-point digital signal processor and a 32-bit stereo codec TLV320AIC23 (AIC23) for input and output. The onboard codec AIC23 uses a sigma–delta technology that provides ADC and DAC. It connects to a 12-MHz system clock. Variable sampling rates from 8 to 96 kHz can be set readily, 8kHz of sampling is used in this project.

The DSK board includes 16 MB (megabytes) of synchronous dynamic random access memory (SDRAM) and 256 kB (kilobytes) of flash memory runs at 255Mhz. Four connectors on the board provide input and output: MIC IN for microphone input, LINE IN for line input, LINE OUT for line output, and HEADPHONE for a headphone output (multiplexed with line output).

The four user dip switches on the DSK board can be read from a program and provides the user with a feedback control interface. The DSK operates at 225 MHz by default.

C.C Studio (Code Composer Studio) V3.1 was used to develop, test and examine output. It acts as an interface to computer and board . CCS includes tools for code generation, such as a C compiler, an assembler, and a linker. It has graphical capabilities and supports real-time debugging[6].

The C compiler compiles a C source program with extension .c to produce an assembly source file with extension .asm. The assembler assembles an .asm source file to produce a machine language object file with extension .obj.

The linker combines object files and object libraries as input to produce an Executable file with extension .out. This executable file can be loaded and run directly on the C6713 processor. It follows architecture similar to Linux.

In this project, audio data of 30sec was taken as input via Line in, sampled at 8Ksamples/sec and 16 bit mono depth. This data was converted to packets, each packet holds 4 sample of 16 bit each, i: e a packet holds 64 bits of data.

A packet is collection of 8 users of data of 8 bit each, a matrix of 8x8. The total numbers of packets depend on the time of audio recorded for 30 sec the total number of samples are 480000 that correspond to120000 packets.

The Steps are such: Transmission :

1)Every packet data which contains binary 1,0 is mapped to a ternary -1,0 and 1 logics. Where binary 0 = -1, binary 1 = 1 and 0 means No data. This remapped data is first spread by 8 bits leading to a matrix of 8x64, where 8 represents 8 users and 64 represents the spreaded data.

2)The spread matrix/data is then Xor'ed with Walsh Hadamard matrix which is 8x8, the spread data bits of user is Xor'ed with its corresponding Walsh code, creating a Encoded matrix. As the user data is 64 bits (due to spreading) it is Xor'ed with its Walsh code 8 times.

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3)Every user repeats step 2 , with its own corresponding Walsh code and generates it own encoded data, this is stored as an Encoded matrix in this project.

4)In practical, every user transmits its own encoded data in air after modulation (BPSK) ,all users transmit simultaneously in synchronous CDMA. Every user's modulated data gets added in air creating a RAW signal or multiplexed signal. This multiplexed signal is generated by adding all rows in this project.

Reception :

5)The RAW signal is the CDMA signal, which is received by all recievers.The same RAW signal is used by all receivers to decode and get back its data which was send by its corresponding transmitter.

6)The procedure for decoding is as such, The RAW signal is 64 symbols wide. Receiver 1 uses the same Walsh code used by Transmitter 1 . It Xor's the RAW signal with Walsh code and receives the data which is then send to thresholder.

7)The thresholder puts a binary 1 if value of symbol is greater than zero, binary 0 if the value of symbol is less than 0 and 0 if the value of symbol is zero (which means No data).

8)The above two steps (6 and 7) are repeated by every receiver to decode their own data, using the same RAW signal.

The above steps (1-8) are repeated for each packet until the transmission of audio data is completed. The received data is stored in buffer and send to AIC23 Codec and played back via Mic pin.

IV. RESULTS & CONCLUSION:

The kit and software used :

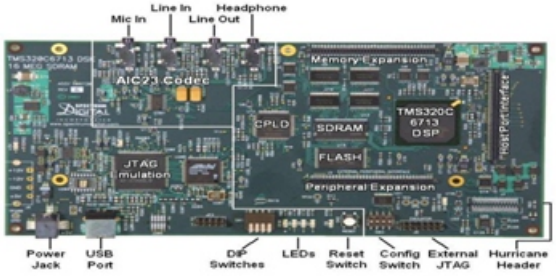

Fig 1 : TMS320C6713 Kit.

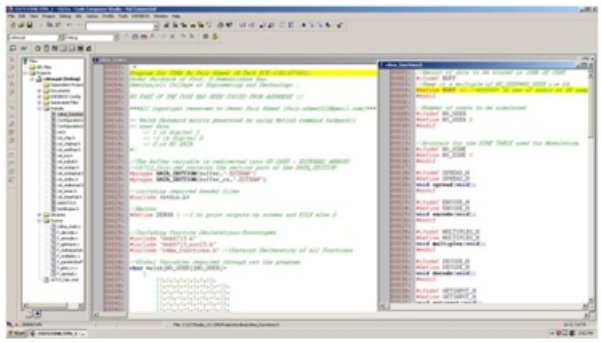

Fig 2: CCstudio with code .

The output was written to a Excel file, shown in Fig 2 using the Kit shown in Fig 1, RTDX (Real Time Data Exchange) protocol allows the DSK kit to communicate with PC while execution.

Packet Information												
1	1	1	1	1	1	-1	1					
1	-1	1	-1	-1	-1	-1	-1					
1	1	1	1	-1	-1	1	1					
-1	1	1	-1	-1	-1	-1	-1					
1	-1	-1	-1	-1	1	1	-1					
1	-1	1	-1	-1	-1	-1	-1					
1	-1	-1	1	-1	1	1	-1					
-1	1	1	-1	-1	-1	-1	-1					
Printing spread												
1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1
1	1	1	1	1	1	1	1	1	1	1	1	1
-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	1
1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1
1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	1
Coded												
1	1	1	1	1	1	1	1	1	1	1	1	1
1	-1	1	-1	1	-1	1	-1	-1	1	-1	1	-1
1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1
-1	1	1	-1	-1	1	1	-1	1	-1	-1	1	1
-1	1	1	-1	-1	1	1	-1	1	-1	-1	1	1
1	-1	1	-1	-1	1	-1	1	-1	1	-1	1	1
1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1
-1	1	1	-1	1	-1	-1	1	1	-1	-1	1	-1
Multiplexed												
	4	4	4	-4	0	0	0	0	0	0	-4	4
USER Decoded												
1	1	1	1	1	1	0	1					
1	0	1	0	0	0	0	0					
1	1	1	1	0	0	1	1					
0	1	1	0	0	0	0	0					
1	0	0	0	0	1	1	0					
1	0	1	0	0	0	0	0					
1	0	0	1	0	1	1	0					
0	1	1	0	0	0	0	0					

Fig 3 : Snapshot of the output saved in Excel file.

The output file and complete project source cannot be represented above(due to size constrain).

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