Performance Optimization of MIMO-OFDM using MMSE-SIC and Hamming Codes

Brijesh Tiwari[1], Prof. Abdul Sami Khan[2], Prof. Mohd. Sarwar Raeen[3]

[1]*Mtech Student,* [2]*Guide,* [3]*HOD*

Depart of Electronics and Communication Engineering, All Saint College of Technology, Bhopal

Abstract - The advancement of multiple inputs multiple output (MIMO) antenna has major influence on enhancement of capacity limit of single antenna system. Within a limited computation complexity. MIMO uses the multiuser technique to improve performance and throughput of system .there is a huge amount of end user in cell site which led demand for high bandwidth and improved BER value. In this paper we have proposed a MMSE –SIC technique for the performance evaluation of MIMO-OFDM system with the help of Matlab signal to noise ratio (SNR) and bit error rate (BER) has been observed by hamming codes in BPSK technology with 1 dimensional digital FIR Filtering and Rayleigh fading channel modulation.

Keyword- MIMO, OFDM, Hamming Codes, FIR Filtering.

I. INTRODUCTION

Increased rates of data in wireless communications systems are turning into a prerequisite encouraged by bigger populaces of individuals joining the new unrest of wireless gadgets. This request directs the utilization of expansive data transfer capacities of data exchange. There are numerous techniques which have been utilized to altogether lessen collector many-sided quality in broadband wireless systems, the most prominent being OFDM. In a push to enhance ghastly productivity in high data rate systems, MIMO wireless systems have been getting a lot of consideration. This technology utilizes numerous reception antennas at both the transmitting and reception end of the radio connection. Consolidating both techniques, MIMO-OFDM has been, among others, under thought for use in the IEEE 802.11n high-throughput performance

A. Orthogonal frequency division multiplexing (OFDM)

There is a growing amount of end-users in the wireless spectrum which has led to a need for improved bandwidth usage and BER values. In other words, new technologies which would increase the capacity of wireless systems are proving to be a crucial point of research in these modern times. Hence, the focus of the research was to examine, identify and establish a detector capable of delivering rates required by the demand of the end users in modern day telecommunication systems. OFDM is a very popular multi carrier modulation cum multiplexing technique for transmission of signals over wireless fading channels.

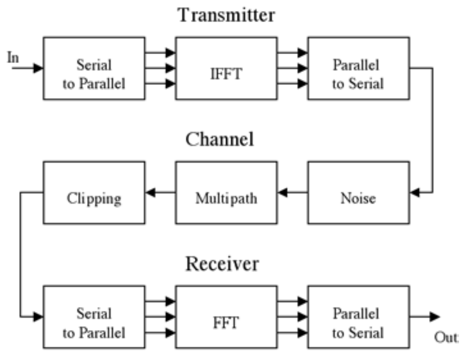

Figure 1.1 Block Diagram of OFDM.

It converts a frequency selective fading channel into a collection of flat parallel fading sub channels, which mostly simplifies the structure of the receiver. Even though the signal spectra related to different subcarriers overlap in frequency domain but the time domain wave form of the subcarriers are orthogonal. So that the available bandwidth is used efficiently in OFDM systems without the inter carrier interference.

B. Multiple Input Multiple Output (MIMO)

MIMO can be categorized into three different areas: precoding, spatial multiplexing, and diversity coding. Precoding refers to the spatial processing that is performed at the transmitter (also known as beamforming). The goal of spatial processing is to reduce the effect of multipath fading from constructive interference of the signals being transmitted. Multipath is a propagation phenomenon that is characterized by the arrival of multiple versions of the same signal from different locations shifted in time due to having taken different transmission paths of varying lengths.

- Precoding is used when a receiver consists of more than one antenna and beamforming cannot maximize the signal level across all receiving antennas

- Spatial multiplexing gain refers to using the degrees of freedom in a communication system by sending independent symbols in parallel over multiple spatial channels.

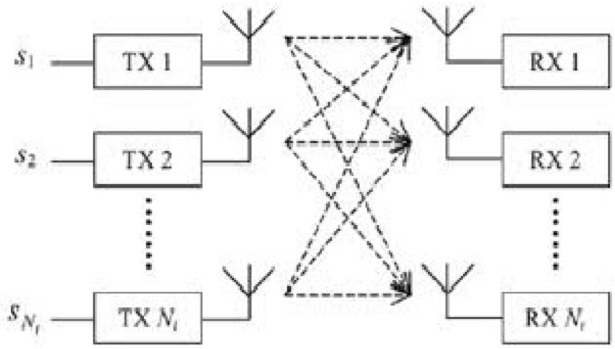

Figure 1.2 Multi user MIMO channel model.

- Diversity coding requires a single stream of data to be encoded with a space-time code prior to transmission.
- Space-time codes create orthogonality among the data being sent to the receiver.

C. MIMO OFDM

Since it has been observed that wideband wireless channels are frequency selective in nature, OFDM can be used in a MIMO system to take advantage of this. MIMO takes advantage of the spatial and temporal dimensions of transmission and adding OFDM into this framework includes the frequency dimension. The general structure for a MIMO OFDM transmitter and receiver.

II. SYSTEM MODEL

A. Transmitter

The transmitter of a general multiple antenna system, as shown in Figure 2.1. Data is first encoded and interleaved. Then a block of N_t symbols is converted from serial to parallel, modulated and then each symbol is fed to one of the N_t antennas. Thus, the N_t symbols are transmitted.

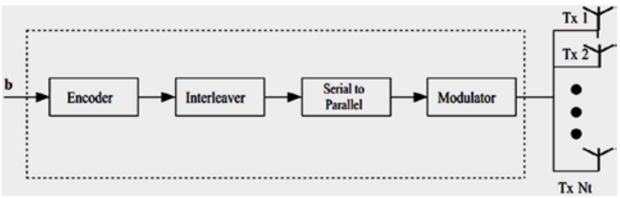

Figure 2.1 Transmitter of general multipath antenna system.

- Encoder

A channel encoder is utilized to present some excess in the twofold data succession, which makes the recipient have the capacity to beat the impacts of commotion and obstruction experienced in the transmission. There are various mistake control codes that we can utilize without further ado, for instance, square codes and convolutional codes.

The interleaver is presented after the encoder, keeping in mind the end goal to guarantee free blurring of the coded bits or images. For tweak, we utilize 16-QAM or QPSK in the proposition, as indicated by the quantity of the antennas. More nitty gritty data about the transmitter modules are appeared in the accompanying parts.

- Interleaver

If the error brought about by the channel is measurably autonomous, then the codes that have been devised for expanding the unwavering quality in the transmission of data are viable. Be that as it may, in a deep channel fading, if the divert is in a profound error, countless happen in arrangement. As it were, there exists burst blunder attributes.

- Modulator

A modulator is a device that performs modulation, and serves as the interface to the communication channel. The basic role of the advanced modulator is to outline paired data arrangement into signal waveforms. Adjustment is the way toward differing a waveform with a specific end goal to utilize that signal to pass on a message. We utilize Quadrature Amplitude Modulation (QAM) as the modulation technique in the theory.

B. Receiver

Figure 2.2 shows the receiver of a general multiple antenna system. First the received vector is sent to a demodulator. Then a block of N_t demodulated symbols is converted from parallel to serial, deinterleavered and decoded. Thus the data transmitted by N_t transmitting antennas are recovered at the receiver.

- Demodulator

A demodulator is utilized to recover the data content from the received signal. In our proposition, the ML demodulator utilizes delicate Maximum A-Posteriori (MAP) to perform demodulation.

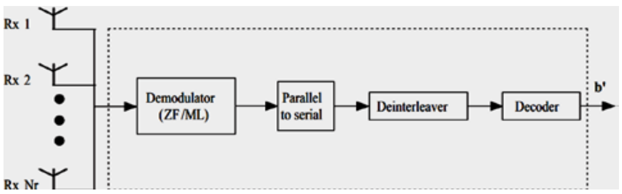

Figure 2.2 receiver of a general multiple antenna system.

- Deinterleaver

At the beneficiary, after demodulation, a deinterleaver is utilized to fix the impact of the interleaver. The deinterleaver puts the data in appropriate arrangement and passes it to the decoder. It stores the data in the same rectangular exhibit arrange as the interleaver, yet it is perused out line savvy.

- Decoder

A decoder is a device which does the turnaround of an encoder, fixing the encoding so that the first data can be recovered. There are a few calculations exist for unraveling convolutional codes. We utilize the Viterbi calculation for convolutional disentangling in this proposition.

III. PROPOSED METHODOLOGY

The basic structure shown in Figure 2.1 and 2.2 of MIMO OFDM transmitter receiver and there modulation technique to eliminate the errors and enhance the performance of the MIMO OFDM a advanced v-blast MMSE modulation technique has proposed. Figure 3.1 block diagram of the proposed system demonstrate the working of the proposed system.

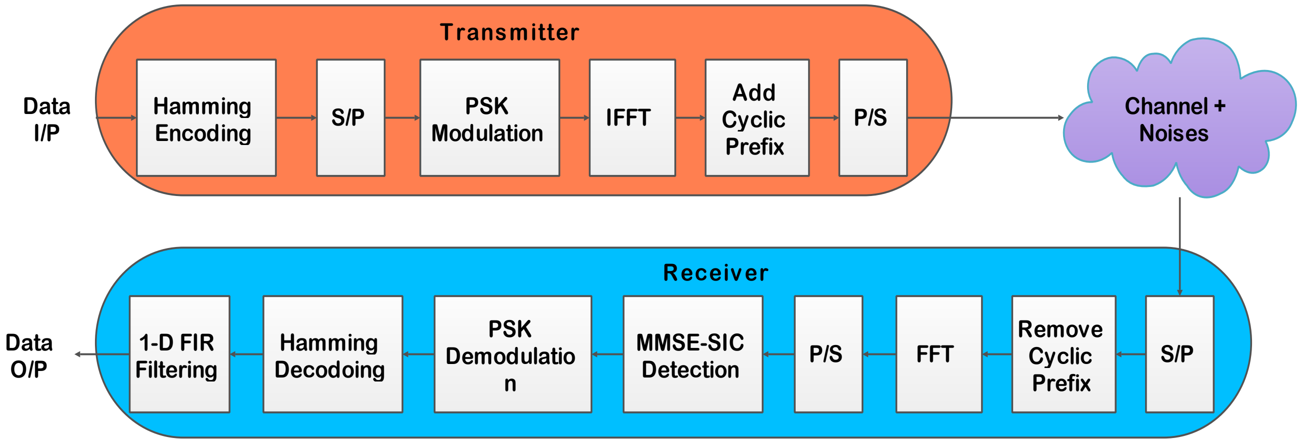

Figure 3.1 Block Diagram of the proposed system.

The proposed system has three major components which are

(1) Transmitter

(2) Receiver

(3) Channel

(1) The transmitter block is further divided in five sections which are

- Hamming Decoding.
- Serial to parallel conversion.
- PSK Modulation.
- IFFT.
- Add cyclic prefix.
- Parallel to serial conversion.

(2) The output section has six blocks which are given as follows

- Serial to parallel conversion.
- Remove cyclic prefix.
- FFT.
- Parallel to serial conversion.
- MMSE –SIC Detection.
- PSK Demodulation.
- Hamming Decoding.
- 1-D FIR Filtering

(3) The MIMO OFDM

Channel has facilitated to high speed communication with multiple input and output antennas to reduce the complexity of communication with reduced noise and channel losses.

the flow chart of the proposed system has shown in figure 3.2 the process of the proposed system has complete in 20 steps as shown in the figure 3.2 create first simulation environment then generate signal then characterize the channel and distribute data among the we are using MIMO channel so the data (information) signal are distributed among number of antennas data is converted from serial to parallel form and QPSK modulation applied on it further modulated by OFDM (IFFT) modulation. Then cyclic prefix added on it to easy recognize the data again converted from parallel to serial form Transmit the data via MIMO OFDM channel some nose are added to it during the transmission of data via channel it is received by the receiver end. Again data is converted in parallel data remove the cyclic prefix from the data received Demodulate by OFDM (IFFT) again parallel data is

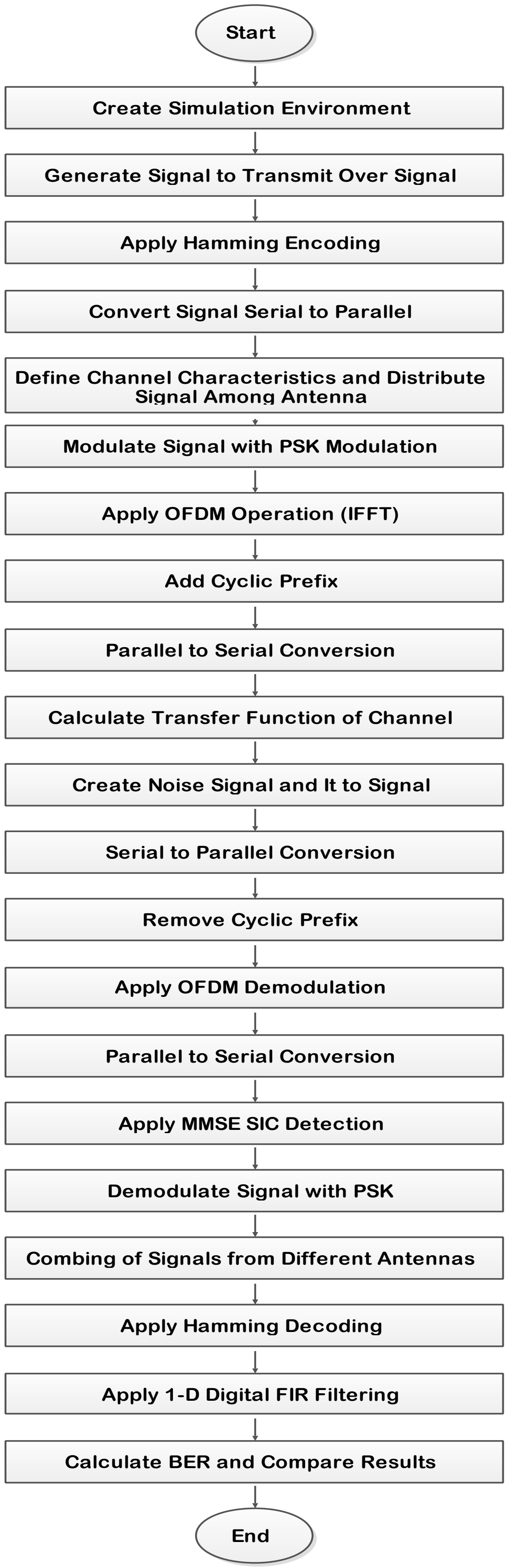

Figure 3.2 Flow Chart of Proposed System.

converted to serial data. MMSE –SIC Detection algorithm applied on it to extract actual data demodulate signal remove noise calculate bit error rate and display result. The above system discussed is simulated on MATLAB environment and result is compared with the result of the existing system. The results of the simulation of the system are given in the next section.

IV. SIMULATION RESULT

The proposed system is simulated with the help of MATLAB simulator the performance of the system is evaluated based on the calculation of bit error rate and the level of noise in the received data the simulation results are given below with the comparison of the existing system.

The simulation outcomes are shown with the statics from figure 4.1 to 4.4 and the comparison are given in the comparison table 4.1.

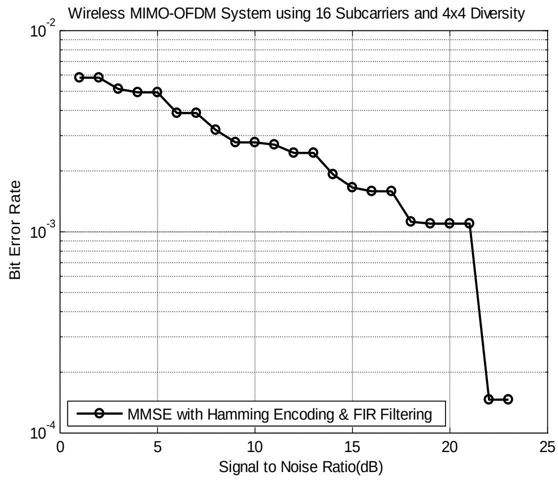

Figure 5.1 Performance of the Proposed MIMO OFDM system with 4x4 Antenna and MMSE –SIC Detection with 16 Sub-carriers.

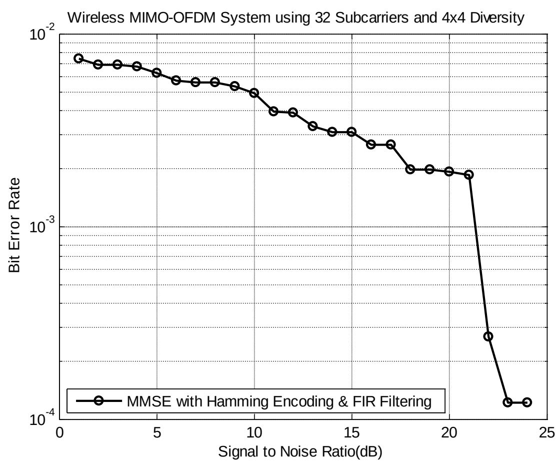

Figure 5.2 Performance of the Proposed MIMO OFDM system with 4x4 Antenna and MMSE –SIC Detection with 32 Sub-carriers.

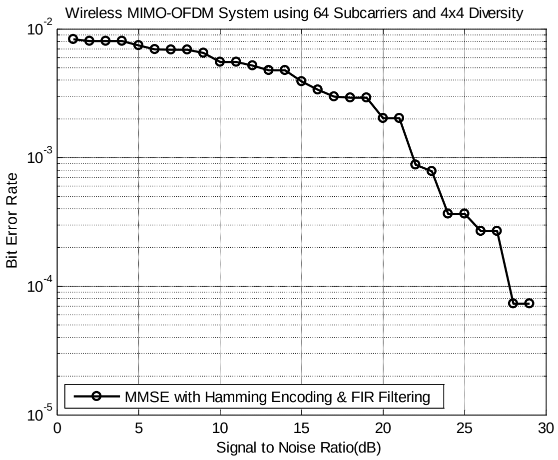

Fig. 5.3 Performance of the Proposed MIMO OFDM system with 4x4 Antenna and MMSE –SIC Detection.

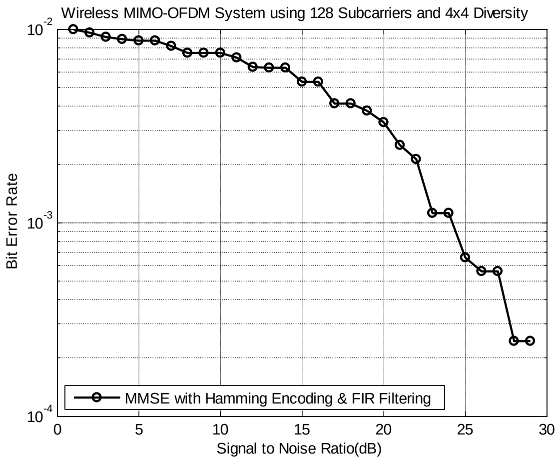

Fig. 5.4 Performance of the Proposed MIMO OFDM system with 4x4 Antenna and MMSE –SIC Detection with 128 Sub-carriers.

Table 4.1: Comparison of BER with Previous Methodology

SNR	Previous BER	Proposed BER
1	$1.10x10^{-1}$	$8.67x10^{-3}$
2	$8.01x10^{-2}$	$8.23x10^{-3}$
3	$6.15x10^{-2}$	$8.23x10^{-3}$
4	$4.75x10^{-2}$	$7.69x10^{-3}$
5	$4.01x10^{-2}$	$7.37x10^{-3}$
6	$2.80x10^{-2}$	$6.98x10^{-3}$
7	$2.15x10^{-2}$	$6.84x10^{-3}$
8	$1.91x10^{-2}$	$6.49x10^{-3}$
9	$1.45x10^{-2}$	$6.49x10^{-3}$
10	$9.11x10^{-3}$	$6.20x10^{-3}$
11	$8.66x10^{-3}$	$6.20x10^{-3}$
12	$6.51x10^{-3}$	$4.79x10^{-3}$
13	$4.25x10^{-3}$	$4.79x10^{-3}$
14	$2.01x10^{-3}$	$4.74x10^{-3}$
15	$4.75x10^{-3}$	$3.61x10^{-3}$
16	$3.00x10^{-3}$	$3.37x10^{-3}$
17	$1.11x10^{-3}$	$2.93x10^{-3}$
18	$1.51x10^{-3}$	$2.49x10^{-3}$
19	$9.11x10^{-4}$	$2.32x10^{-3}$
20	$7.22x10^{-4}$	$2.32x10^{-3}$
21	-	$2.32x10^{-3}$
22	-	$1.15x10^{-3}$
23	-	$9.52x10^{-4}$
24	-	$4.39x10^{-4}$
25	-	$4.39x10^{-4}$
26	-	$2.20x10^{-4}$
27	-	$7.\ 20x10^{-5}$

V. CONCLUSION AND FUTURE SCOPE

MIMO upgrades the limit of the system and can be utilized as a part of conjunction with multi-user strategies to enhance system throughput. There is a developing measure of end-clients in the remote range which has prompted to a requirement for enhanced data transmission use and BER values. As it were, new advancements which would expand the limit of remote systems are ended up being an urgent purpose of research in these cutting edge times. Henceforth, the concentration of the exploration was to inspect, recognize and set up a locator equipped for conveying rates required by the request of the end user in cutting edge media transmission systems.

From simulation and our come the results are incredibly enhanced the bit error rate are reduced and level of noise is reduced comparatively further the same modulation technique can also be used for the different OFDM technologies in wireless communication.

REFERENCES

[1] H. R. Bhaliya, A. Patel and S. K. Chhotaray, "Optimal ordering technique for performance improvement of MIMO-OFDM system using V-BLAST algorithm," Electrical, Electronics, Signals, Communication and Optimization (EESCO), 2015 International Conference on, Visakhapatnam, 2015, pp. 1-4.

[2] A. U. Toboso, S. Loyka and F. Gagnon, "Optimal Detection Ordering for Coded V-BLAST," in IEEE Transactions on Communications, vol. 62, no. 1, pp. 100-111, January 2014.

[3] J. J. van de Beek, O. Edfors, M. Sandell, S. K. Wilson and P. O. Borjesson, "On channel estimation in OFDM systems," Vehicular Technology Conference, 1995 IEEE 45th, Chicago, IL, 1995, pp. 815-819 vol.2.

[4] A. van Zelst and T. C. W. Schenk, "Implementation of a MIMO OFDM-based wireless LAN system," in IEEE Transactions on Signal Processing, vol. 52, no. 2, pp. 483-494, Feb. 2004.

[5] B. Gupta, G. Gupta and D. S. Saini, "BER performance improvement in OFDM system with ZFE and MMSE equalizers," Electronics Computer Technology (ICECT), 2011 3rd International Conference on, Kanyakumari, 2011, pp. 193-197.

[6] P.W. Wolniansky, G. J. Foschini, G. D. Golden, R. A. Valenzuela," V-BLAST: An Architecture for Realizing

Very High Data Rates Over the Rich-Scattering Wireless Channel," Bell Laboratories, Lucent Technologies, Crawford Hill Laboratory 791 Holmdel-Keyport Rd., Holmdel, NJ 07733,1998.

[7] Shreedhar A Joshi, Dr. Rukmini T S and Dr. Mahesh H M," Analysis of V-BLAST Techniques for MIMO Wireless Channels with different modulation techniques using Linear and Non Linear Detection,"IJCSI International journal of computer science issues,special issues, ICVCI-2011,vol.1,2011.

[8] NishaAchra,GarimaMathur,Prof. R.P. Yadav," Performance Analysis of MIMO OFDM System for Different Modulation Schemes under Various Fading Channels,"InternationalJournal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 5, May 2013

[9] Esteban R. Guerrero,Giovanny A. Tello,Fengfan Yang," Simulation And Perfomance Analysis For OrderingAlgoritham In ZF And MMSE Detectors For V-BLAST Archi-tectures,"International Conference on Computer Science and Network Technology.

[10] MitaleeAgrawal and YudhishthirRaut, "BER Analysis of MIMO OFDM System for AWGN & Rayleigh Fading Channel," International Journal of Computer Applications, vol.-34, no.-9, November 2011.

[11] PallaviBhatnagar,Jaikaran Singh, MukeshTiwari, "Performance Of MIMO-OFDM System For Rayleigh Fading Channel," International Journal Of Science And Advanced Technology, vol.-1, no.-3, May 2011.