RESEARCH ARTICLE OPEN

Investigate the Performance of LG 00 Mode in Cost Effective Hybrid Radio over Multimode Transmission System

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ABSTRACT
Radio over fiber (RoF) technology composed for apprehension of future high performance integrated networks and future broadband networks. Multimode fiber links can offer a convenient approach for low cost and short Radio over Fiber (RoF) systems. This work is based on the cost effective radio over multimode transmission system (Ro-MMF) for long reach transmission. Error free transmission of 10 Gbps data with 10 GHz radio signal over multimode fiber link successfully demonstrated over 40 km. furthermore, The results are represented for Ro-MMF system by using LG (Laguerre-Gaussian) 00 mode. The Performance of LG 00 mode in terms of SNR and Eye diagram investigated in proposed system.
Keywords: Multimode fiber, Radio over multimode fiber (Ro-MMF), Laguerre-Gaussian (LG) 00 mode, Radio over fiber (RoF).

I. INTRODUCTION

For the future strategy of broadband, the optical network services over wired and wireless media have been considered worldwide. The Radio-over-fiber (RoF) system has been observed as a propitious system to demonstrate the generation and transmission of microwave and millimeter wave signals over optical fiber [1]. ROF systems are accomplished to perform various mobility functions like signal processing, signaling, amplification and Up-conversion/down-conversion etc., which reduce maintenance, and installation costs at the base station. RoF is an expedient over traditional wireless communication techniques include low loss, high speed, low cost and immune to radio frequency interference [2-3].

In RoF systems, multimode optical fiber (MMF) offers remunerative solution because of large core diameter for easy coupling and splicing. MMF is advantageous in building scenarios. Recent studies on MMF have reported enormous performance of MMF to enhance the system capability in short distance. Furthermore the Radio-Over-Multimode fiber (Ro-MMF) is the attractive technique that can able to bear multiple standard signals and offering high bandwidth ad low operating cost. Many researchers pay attention towards numerous Ro-MMF techniques such as optical frequency multiplication, which is vigorous against model dispersion impairment and able to deliver the good quality radio signal beyond 5 GHz [4]. Likewise some researchers worked on link design rules of Ro-MMF systems for short range by using the central launch technique that resolves the impact of modal noise fluctuations and frequency chirp on Ro-MMF links was included to optimize the capability of the receiver [5]. Furthermore, the work on Ro-MMF showing the multiple receiver techniques compared with simple detection by using N-QAM radio signals. Incessantly rising cloud computing technology entails high-speed optical link with high data rates. [6] The huge varieties of Ro-MMF techniques have been demonstrated over the past few years. By acquainting wavelength-division-multiplexing (WDM) technologies can facilitate the network area and improve the antenna sites. Nowadays fiber-to-the-home (FTTH) is consummated with WDM techniques and able to conduct bidirectional signal with high data rate. It is emphatic to connect Ro-MMF with WDM system by using multiple channels in order to cover large area [7]. Spatial Laser hired Laguerre-Gaussian (LG) modes, which has rotational symmetry along their propagation axis modes in which the field components in the direction of propagation are small compared to components perpendicular that direction [8].

In this work, we have designed the cost effective high-speed hybrid RoMMF system with simultaneous transmission of 10 Gbps data along with 10 GHz radio signal over optical span of 40 km [9]. Furthermore, the LG 00 mode is also investigated in this proposed system. The paper is organized as follows: Section II describes the simulation setup then results from the simulation setup are presented and discussed in section III Finally, the conclusion of this work are summarized in section IV.

II. SIMULATION SETUP OF PROPOSED SYSTEM:

Fig.1 shows our designed 10 Gbps-10 GHz Ro-MMF transmission system. A 10 Gbps data generated by pseudorandom bit sequence generator is Fed to non-return to Zero encoder. Electrical multiplier combined the resulting signal from two signal generators. By Using LiNb3 modulator derived by spatial continuous wave laser modulates the 10 Gbps-10 GHz signal. LG 00 mode is generated by using spatial Laser as shown in fig 2. The optical signal transmits over multimode fiber up to 40 km optical span. At the receiver side, Avalanche photodiode (APD) spatial Photo detector is used for receiving the optical signal. The output is then fed to the Low pass roll off cosine filter having 0.5 roll off factor to recover the 10 GHz radio signal. The results observed in terms of SNR and eye diagram from BER tester and electrical spectrum analyzer.

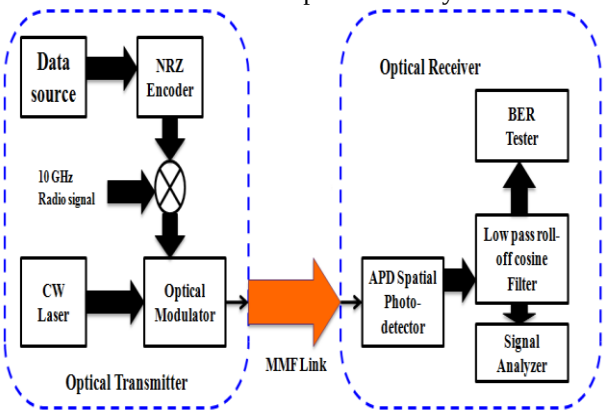

Fig.1. Architecture of proposed system

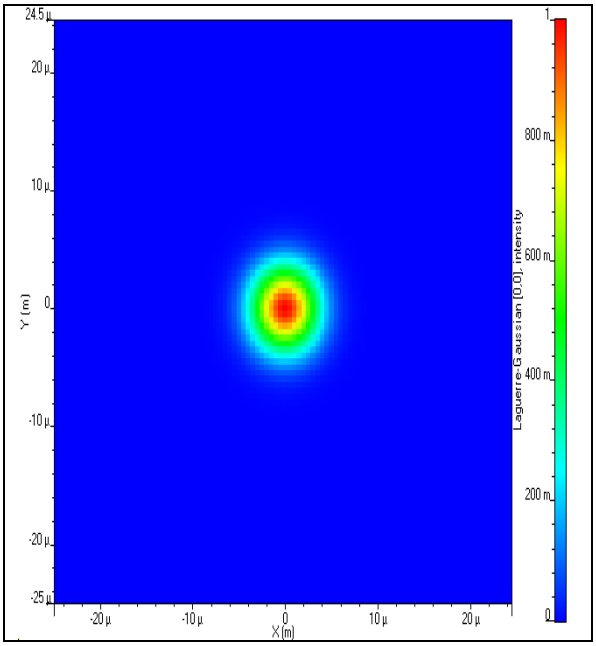

Fig.2. LG 00 mode excited by spatial CW laser

III. INVESTIGATION OF LG 00 MODE IN TERMS OF RESULTS AND DISCUSSIONS:

The prospective of Ro-MMF for broadband ROF transmission with 10 GHz radio signal has been theoretically justified in this work. The performance of 40 km optical span for radio frequency 10 GHz-10 Gbps data is measured in terms of Q-factor and eye diagram. Q-factor measurements and eye diagrams for 10 Gbps data rate with 10 GHz RF signal are presented in fig.3. The signal response is measured with Q-factor in the eye diagram. It is observed that the eye diagram of LG 00 mode at 10-40 km fiber length has best performance than other modes it has sharp Q factor response so that it has higher impedance as well and eye opening is showing the quality of signal response. The quality of signal is best in the LG 00 mode. The eye diagram is more precise in 10 km length of MMF link but in length of 40 km the eye diagram is little fluctuate in each modes.

Fiber Length (km)	SNR of LG 00 mode (dB)
10	28.6588
20	25.5195
30	21.5644
40	17.5015

Table 1. Interpretation of SNR against 10-40 km optical span for LG 00 mode.

It is revealed from the table 1. That the improvement of SNR is 3 dB at 10 km, 4 dB at 20 km, 4 dB at 30 km with LG 00 mode. From previous work, LG 00 mode has better performance and it can be investigated by using Bit error rate tester and signal analyzer which shows the Eye diagram response.

In Fig 3. It reveals that the investigation of LG modes for proposed Ro-MMF transmission system. The eye response for LG 00 mode is more precise at 10 km to 30 km range and it prolongs to 40 km. At 40 km the eye is little fluctuated because of range increases. It is investigated that the LG 00 mode is beneficial up to 40 km range. Moreover, the eye is getting distorted in terms of noise when range increased.

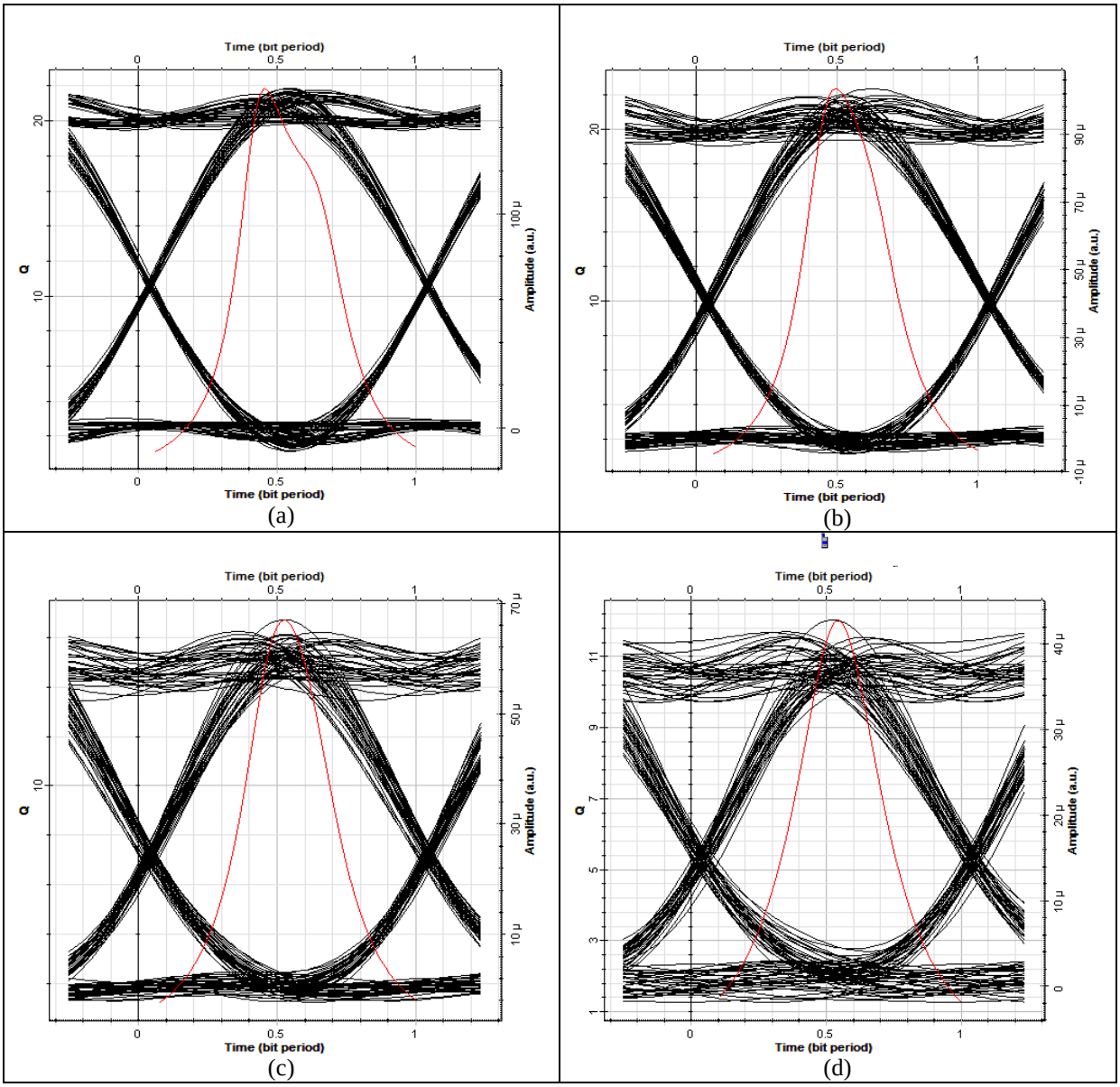

Fig 3. Eye Pattern of LG 00 mode at various fiber lengths with Q-factor response. (a) LG 00 mode response at 10 km (b) LG 00 mode response at 20 km (c) LG 00 mode response at 30 km (d) LG 00 mode response at 40 km.

IV. CONCLUSION:

The experimental results performed in this work to originate a novel technique for long haul transmission 10 Gbps data along with 10 GHz radio signal. From previous work, it is investigated that LG 00 mode has best performance with less distortion. Moreover, the performance of the system is evaluated by using LG 00 mode through MMF link. When the length of Multimode fiber is greater than 30 km, the Eye diagram performance fluctuates slightly at the end but throughout the system attains acceptable Q-Factor. It is reported that the LG 00 mode performs constantly equal up to optical span 40 km. The high transmission capacity could be achieved combining the proposed scheme with integrated wavelength division multiplexing techniques

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