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Performance study of wireless optical communication system under Euphrates River Water

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Abstract:

An underwater wireless optical communication system has implemented utilizing IM/DD-FM through Euphrates river water channel. the wavelengths (650,532,405) nm has used to modulated the frequency over optical signals with an optical power (50) mw, (7) mw and (6) mw receptively. The information signal (3.3) kHz has achieved for Euphrates river water channel. The results benefit that the wavelength 650 nm outperforms than 532nm and 405nm in the proposed water channel. The maximum transmission reaches to (3) m for 650nm wavelength and (2) m for the others wavelengths. Signal to noise ratio, Power and laser beam profile has calculated then demonstrated an accepted value for the utilized wavelengths under the proposed system.

Keywords: Optical Communications, Signal to Noise ratio, Direct Detection - Intensity Modulation, Euphrates River.

1-Introduction

Recently, underwater wireless optical communication (UWOC) systems has been attractive solution as it can give a higher transmission rate [1]-[6]. In Contrast with radio-frequency (RF) and acoustic communications, UWOC has a significantly higher band width, compacted size, low power intake and modulation bandwidth is much giving considerably higher transmission rate. UOWC finding a huge interest and application for natural observing, underwater oil pipe examination, and seaward investigation. Since fast growing of UWOC system, the requirements has raised for long-range and high speed optical waves.

The performance of UWOC system depending on long underwater link and high transmission rate which are the main worries of system architects.

2-Experimental Setup

The proposed experimental setup of an underwater wireless optical communication system based on a directly modulated lasers diode consist of transmitter, water channel and receiver as illustrated:

Transmitter: which is content three different lasers diode of wavelengths (650,532,405) nm, and laser driver circuit which in its term consist of FM modulator and audio unit to transmit (3.3 kHz) from a transmitter side to a receiver.

Water Channel: the unguided medium in which the laser beam is propagate through water tank along transmission link .

Receiver: it presents a photoresister with a demodulator part then the signal is output by a speaker.

A tank water of (1×0.4×0.3) m^3 length, wide and high respectively has designed with glass thickness of (10mm), filled with (80 liter) of Euphtares river water, the window has a thickness of (3 mm) width (38 cm) and a height of (4 cm).The tank water has covered with a black paper cover in order to block the ambit light that causing scattering and reflections within the tank water. Fig. (1) Show setup of experimental work.

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3. Results and Discussion:

Received power for three wavelengths along transmission distance has shown in in fig. (2). In the case of 650nm, the transmission distance

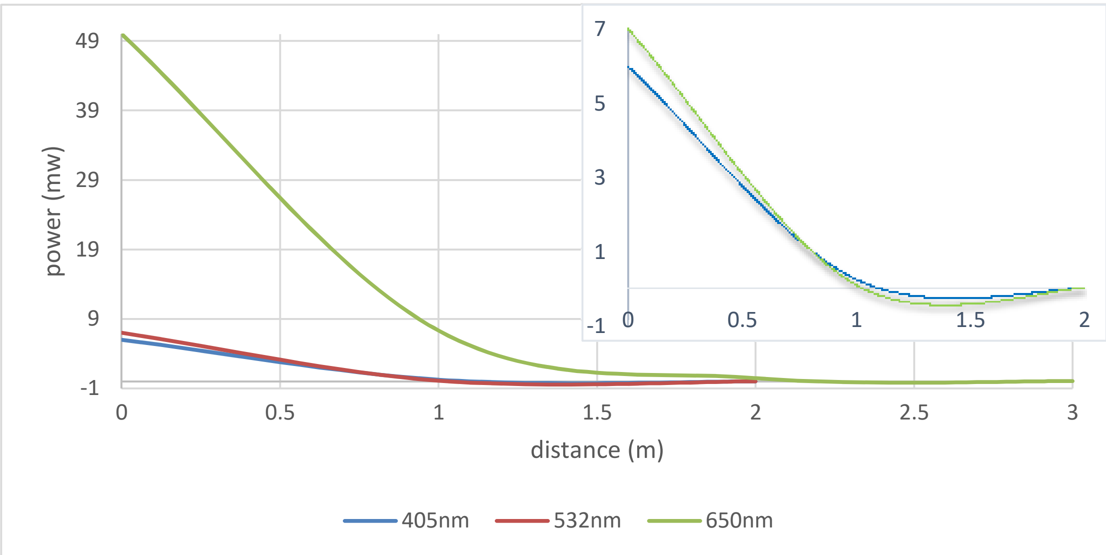


Figure (2) received optical power vs. Distance for Euphrates Water

Signal to noise ratio has calculated at the maximum transmission distance based on DSO measurements, eq.(1) employed to calculated SNR [7].

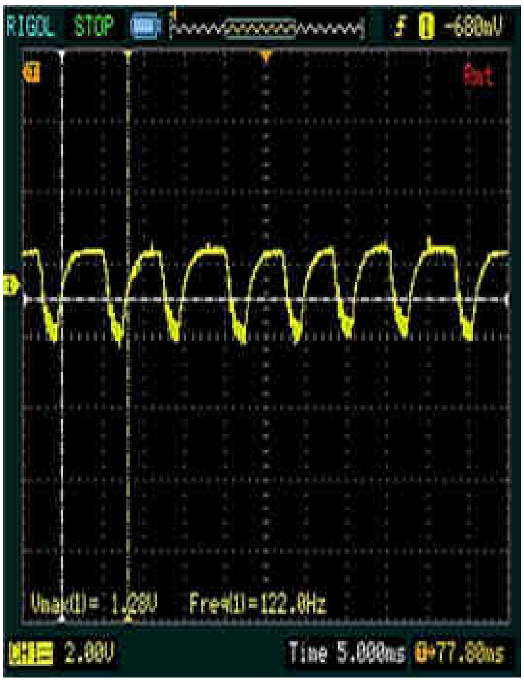
$$SNR\ (dB) = 10\log_{10}\frac{(high-low)}{low} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

SNR at maximum transmission distance for the proposed water channel has illustrated in table (1). The record signal by DSO has shown in fig.(3),fig.(4) and fig.(5).

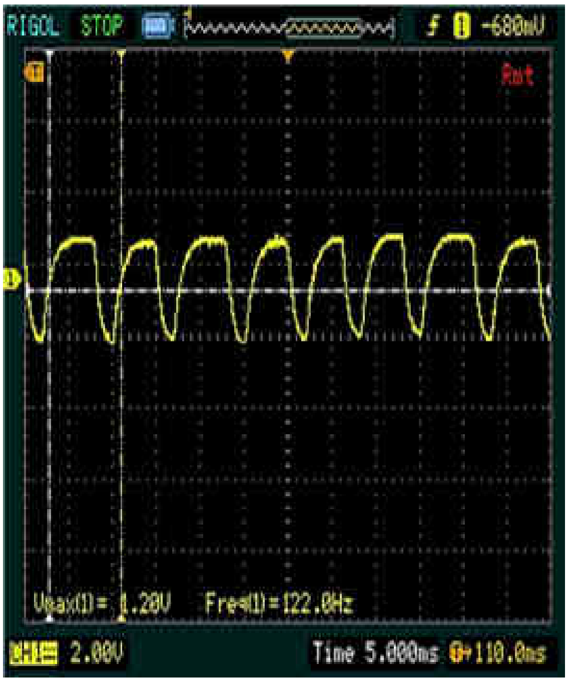
Table (1) SNR VS. distance link for water Euphrates channel

Types of water	Wavelengths (nm)	Max link (m)	SNR (dB)	
			With Lens	Without Lens
Euphrates water	Red (650)	3	23.80	20.29
	Green (532)	2	28.23	24.88
	Blue (405))	2	25.38	25.85

(a)



(b)



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(c) (d)

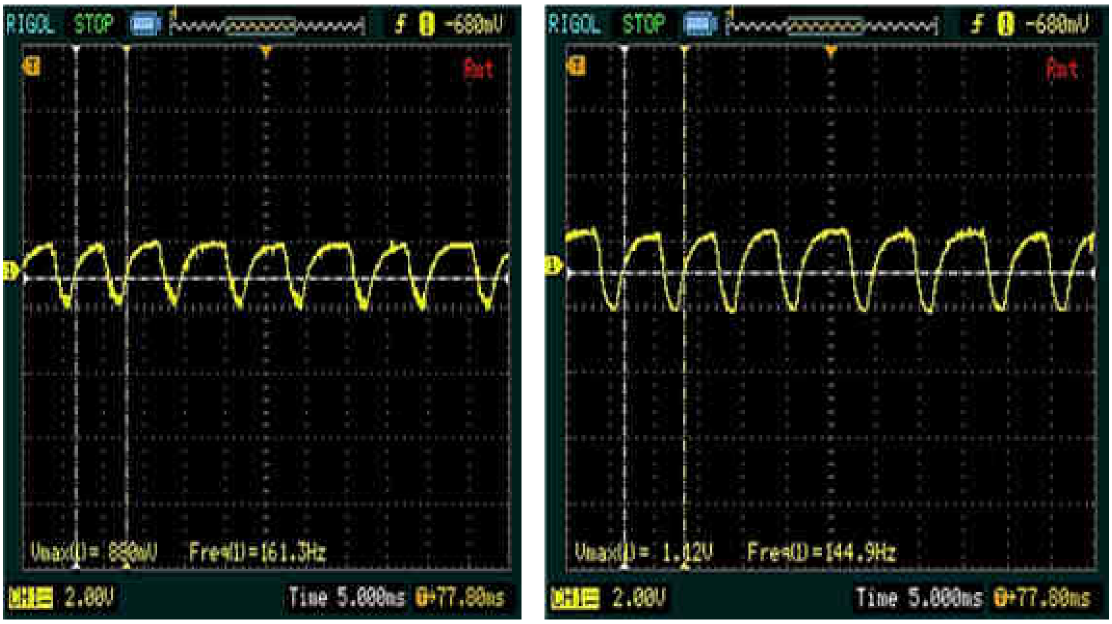
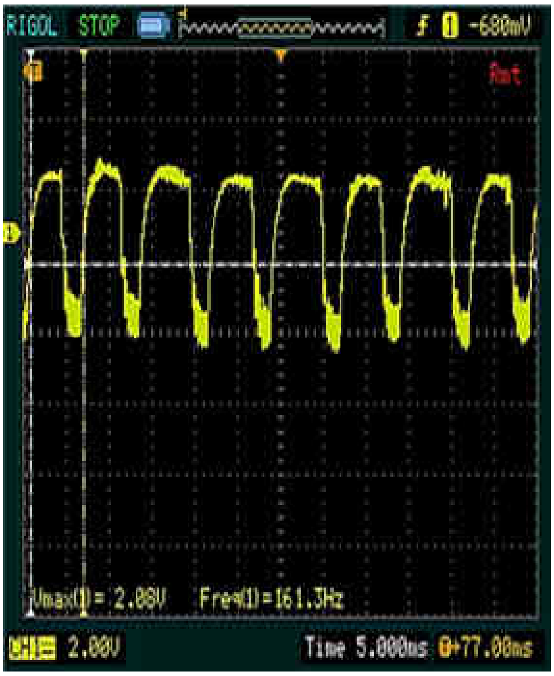
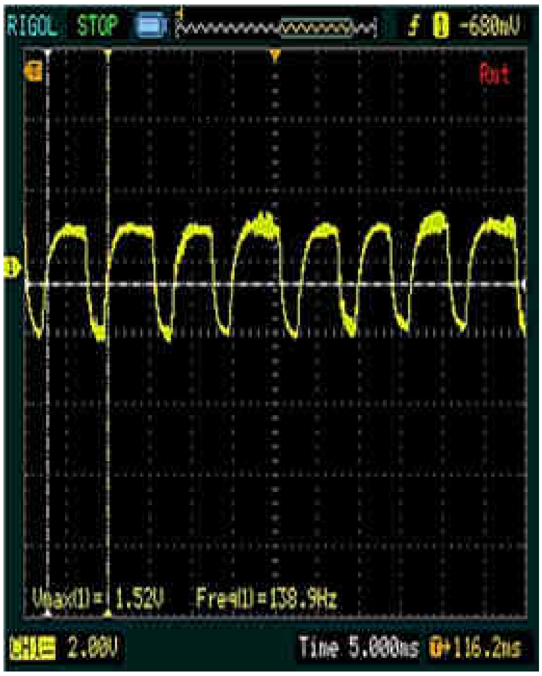


Fig. (3) Waveform of Red laser (650) nm at max. Link for Euphrates water, where (a) with lens with sound (b) with lens without sound (c) without lens with sound (d) without lens without sound

Tabel (1) benefit that the 650nm wavelengths outperforms than the other wavelengths under study along the proposed channel, because of that the longest wavelength 650nm has poorly scattered by the suspended particles, in this case 650nm can pentrate these particles. However, (532,405)nm suffered from Mie scattering, that is make it can not pentrate the suspended particls when scattering is the main factor can affect the attenuation of laser beam [8].



(c)



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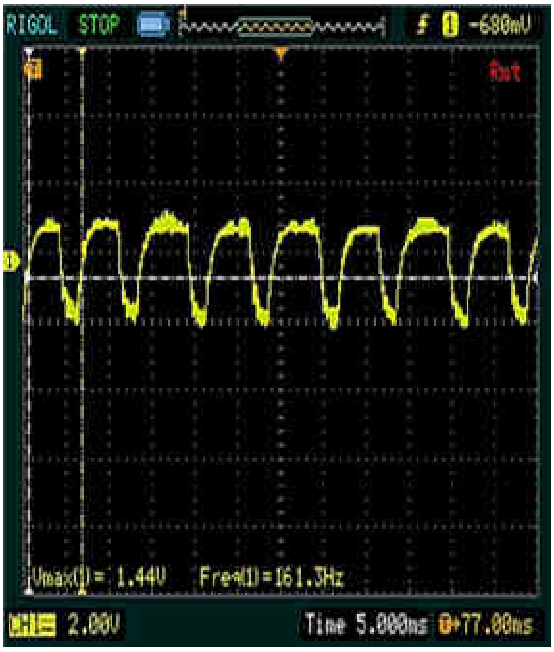

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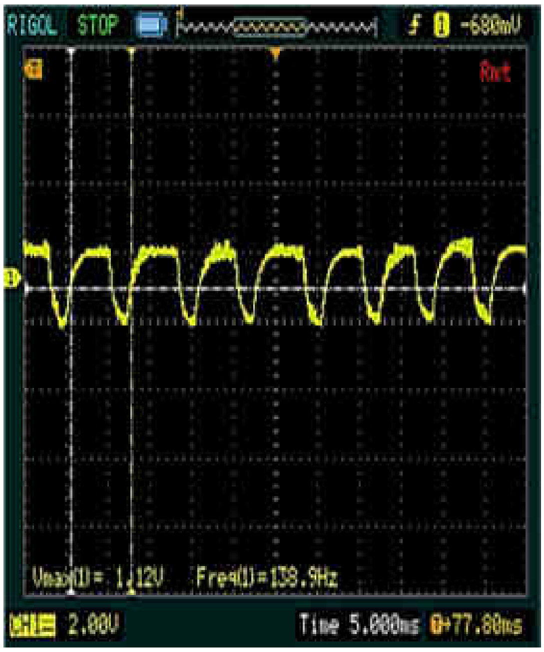
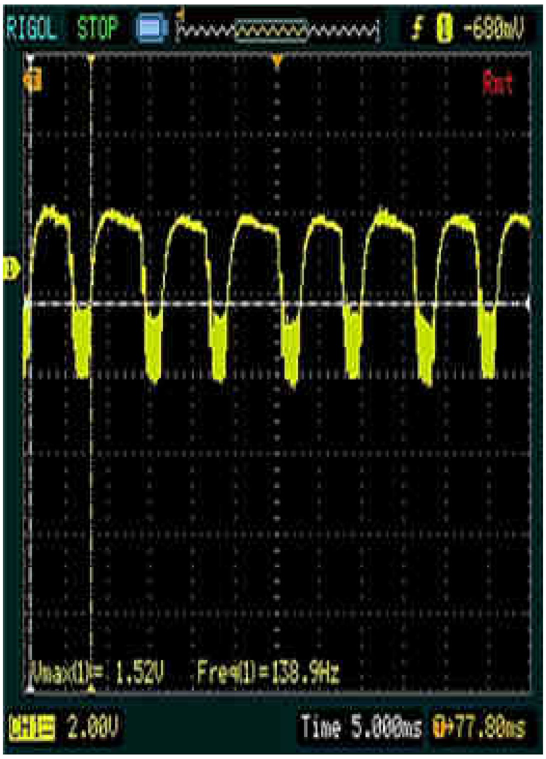
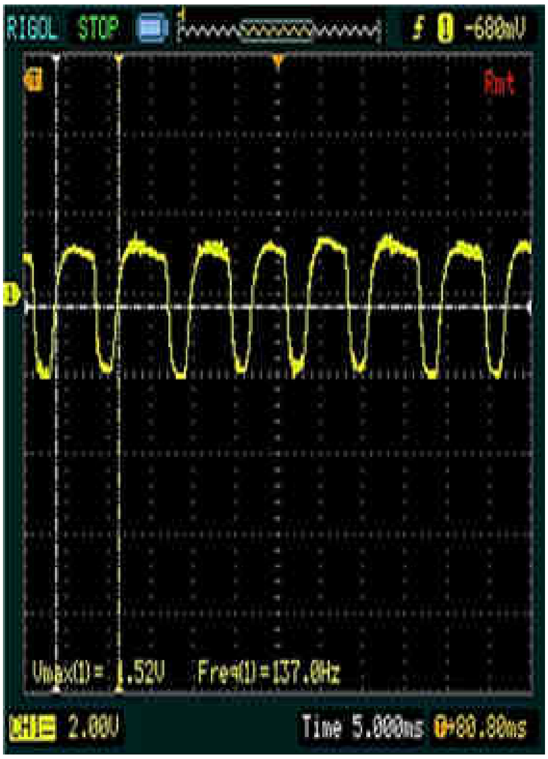


(d)

Fig. (4) Waveform of green laser (532) nm at max. Link for Euphrates, where (a) with lens with sound (b) with lens without sound (c) without lens with sound (d) without lens without sound



(a)



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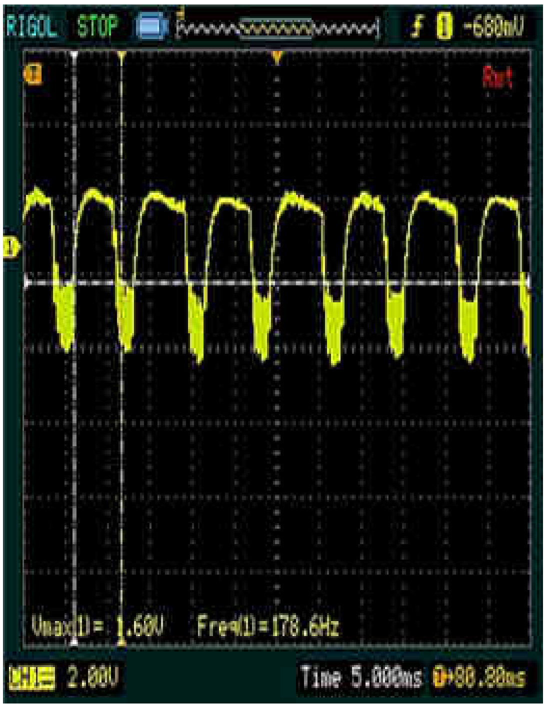
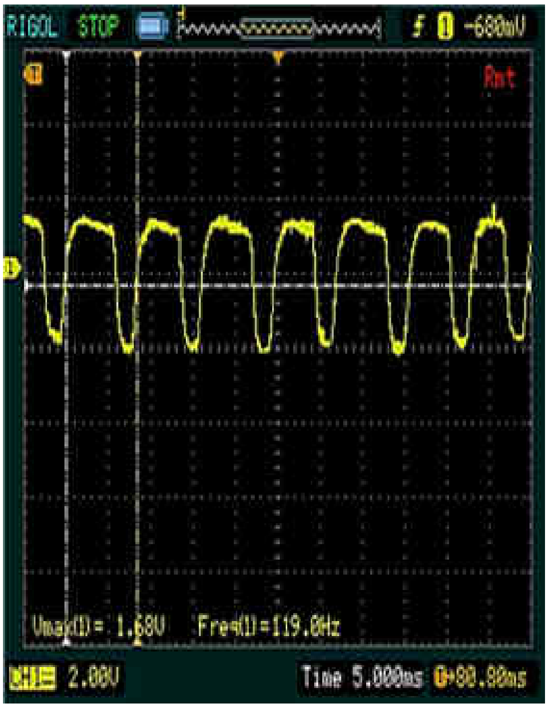


(c)

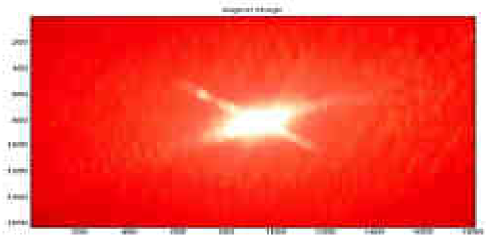


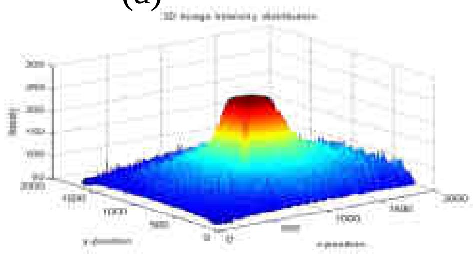
(d)

Fig. (5) Waveform of blue laser (405) nm at max. Link for Euphrates, where (a) with lens with sound (b) with lens without sound (c) without lens with sound (d) without lens without sound

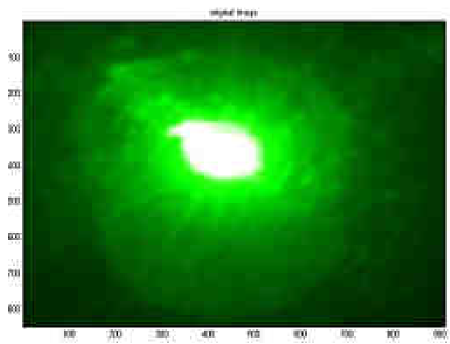
A matlab program has composed to analyze the beam profile. A spot of laser record by a digital camera. Fig.(6) shown the view of spot and profile intensity befor entering the water tank for the wavelengths under study.

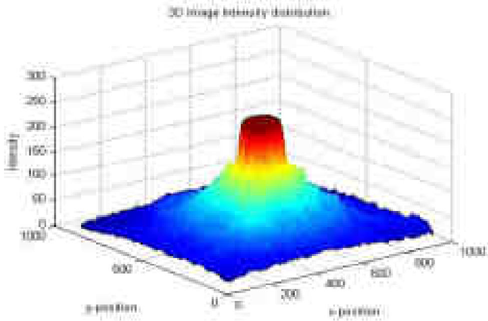
(a)





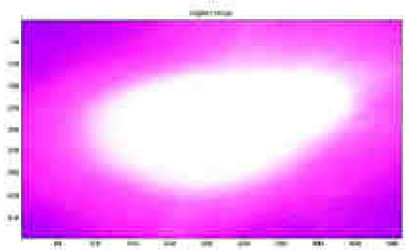
(a) (b)

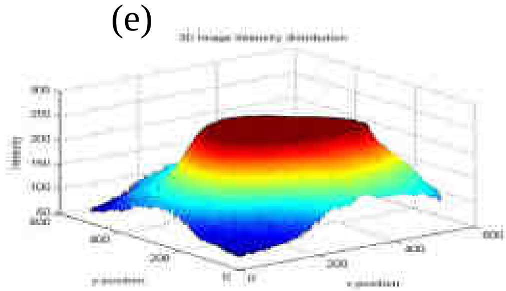




(c) (d)

(e)

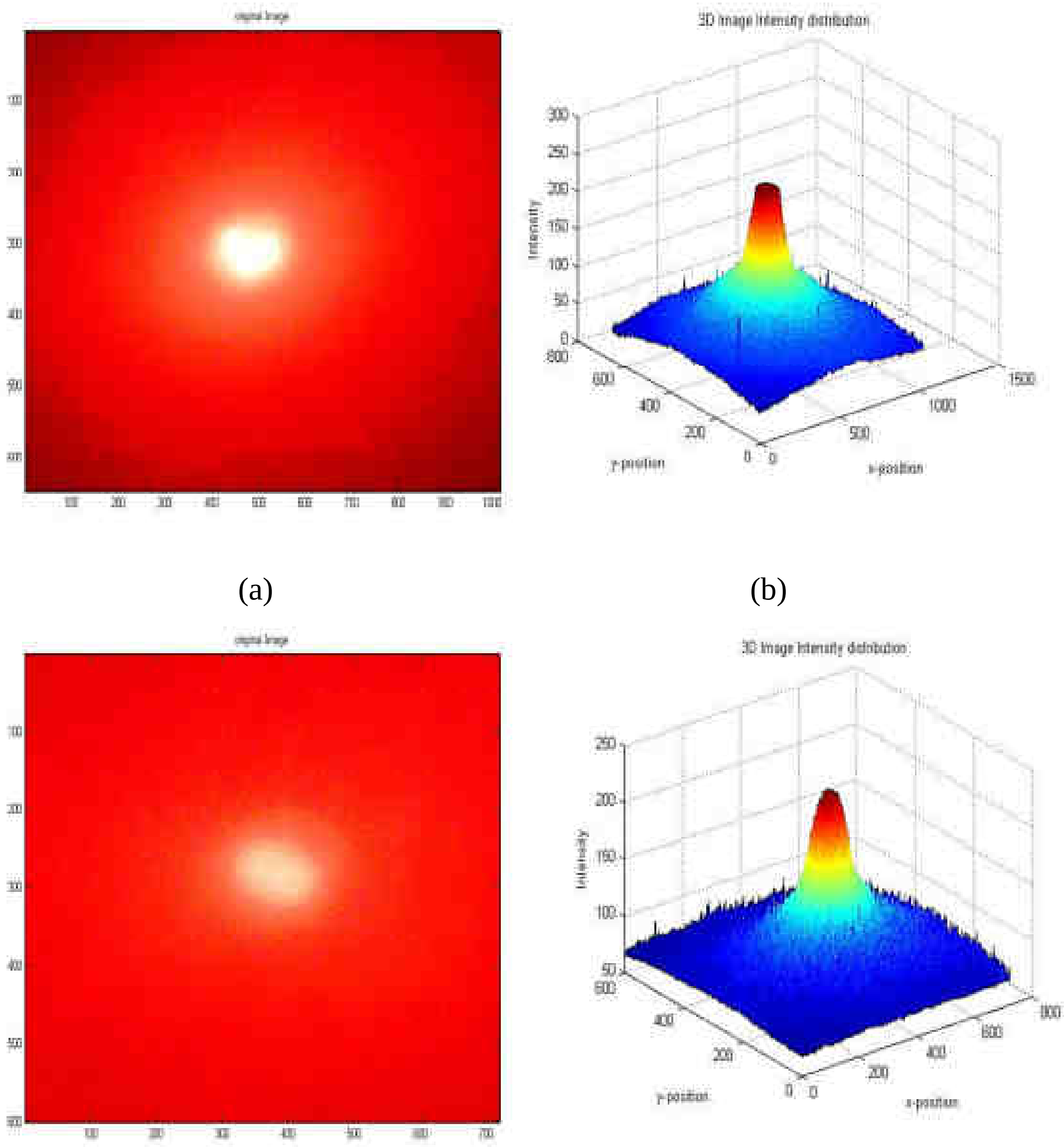




(e) (f)

Fig. (6) profile beam befor enter the water, & (b):(650) nm, (c) & (d):(532) nm, (e) & (f):(405) nm

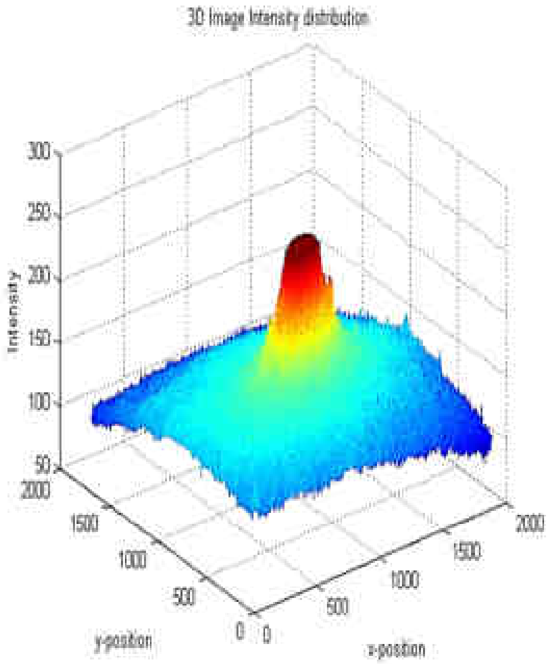
A Euphrates river water channel has used to study a profile beam laser of Iraq water. The profile beam analysis depended on maximum transmission Link, received power and divergence angle. The peak of profile beam seems wider with increase transmission distance and increase of turbidity of water as shown fig. (7), fig. (8) and fig. (9).



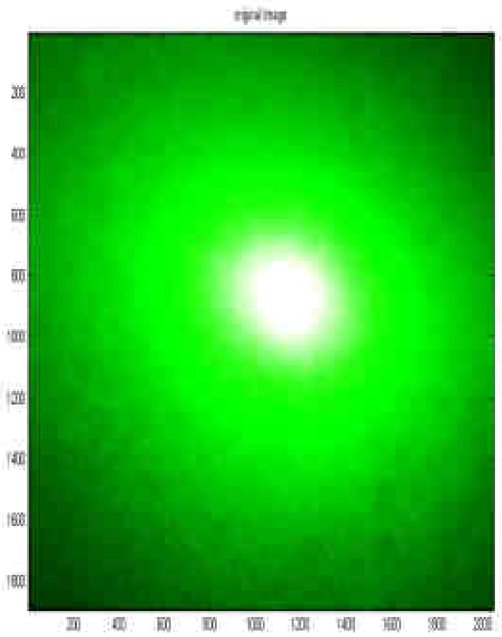
(a) (b)

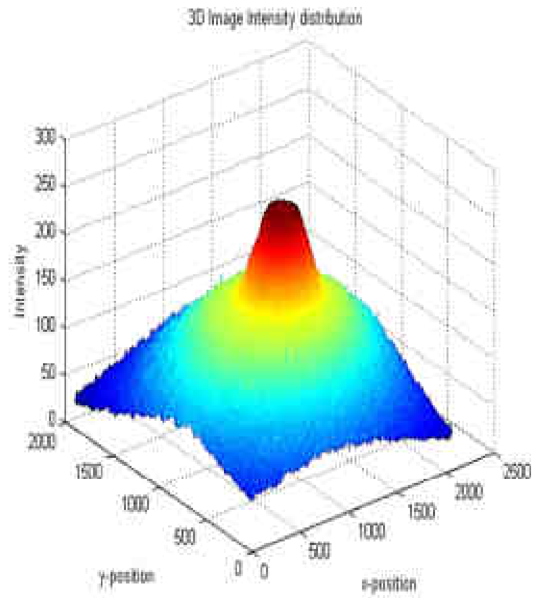
(c) (d)

Fig. (7) profile beam show the relation between the Euphrates water for red laser where (a) & (b) with lens (c) & (d)without lens.



(a) (b)





(c) (d)

Fig. (8) profile beam show the relation between the Euphrates water for green laser where (a) & (b) with lens (c) & (d)without lens.

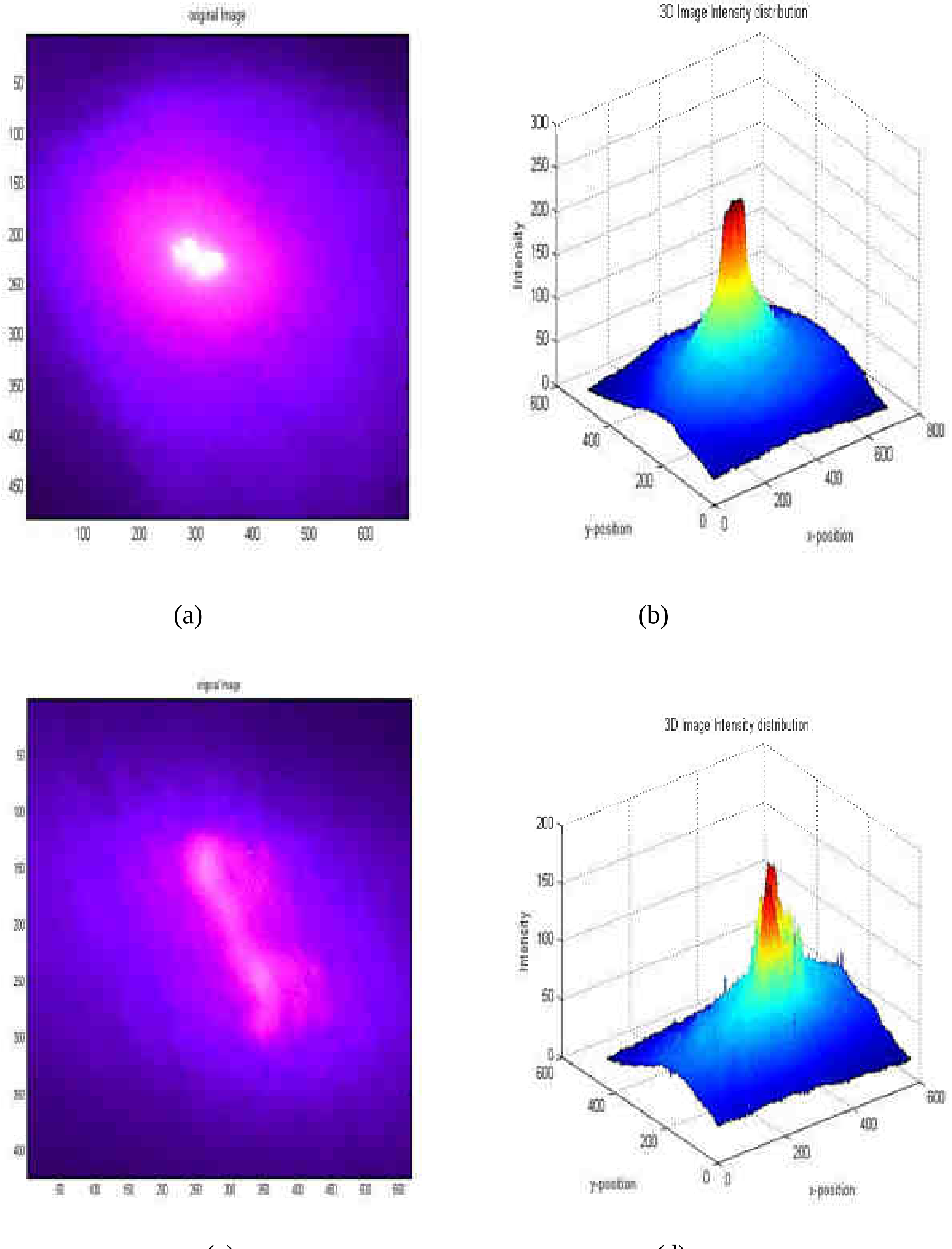


Fig. (9) profile beam show the relation between the Euphrates water for blue laser where (a) & (b) with lens (c) & (d)without lens.

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Conclusion

In this paper, the possibility of applying Intensity Modulation/Direct Detection (IM/DD) has experimentally demonstrated in an UWOC. The result shows that the calculated signal to noise ratio have an acceptance value. in other words, the received optical signals have maintained their power. A lasers beam profile slightly differs because that the proposed water channel has higher turbidity. The measured values of (p_r) has decreased with increasing the transmission distance. Also, it has decreased with increasing the turbidity of water channel. However, increasing water turbidity leads to shift via the utilized wavelengths to the longest which is the red wavelength.

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