Effect of Communication Channel on Transferred Data

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Abstract

This paper gives an informative overview about communications technology through connecting two computers nodes via wired and wireless media. UTP connection is taken as wired media. WiFi and Bluetooth are used as wireless media. Three types of data (text, audio, and image) are transferred through the specified connection. Then, distance and throughput are tabulated with fidelity measures. The practical results with the effective distance for each data type are given and discussed. The effectiveness of the fidelity metrics are classified.

Keywords: UTP , WiFi , Bluetooth , Fidelity measures.

1. Introduction

The digital information revolution has brought about profound changes in our society and our lives. The many advantages of digital information have also generated new challenges and new opportunities for innovation. Along with software , new devices ,such as ,digital cameras , scanners , printers , digital voice recorder, digital audio encoding(mp3) player ,have reached consumers to create , manipulate and enjoy the multimedia data . the Internet and wireless network offer ubiquitous channels to deliver and exchange information [1].

The Internet is considered to be one of the major events of the recent years, information becomes available on –line, all users who have a computer can easily connect to the Internet and search for the information they want to find. The result is that everybody can read the latest news on-line and consult digital libraries, read about firms, universities, cultural events, exhibitions, etc. In addition, the companies can sell their products through the Internet, using electronic commerce [2].

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In recent years with the massive rise in popularity of mobile and fixed electronic computing devices (PCs, PDAs, Laptops, Mobile phones, etc.), there has been a growing demand for high speed digital wire and wireless communication facilities [3].

Communication channels can be divided into: wired channels (such as Twisted pairs ,coaxial cables ,and fiber cables), and wireless channels such as radio transmission , microwave transmission , infrared waves , Bluetooth and light wave transmission [4][**5**].

Bluetooth is a short-range, low cost, and low power radio technology operating in the unlicensed 2.4GHz ISM (Industrial-Scientific-Medical) frequency band [6].

Wi-Fi (short for "wireless fidelity") is a term for certain types of wireless_ local area network (WLAN) that use specifications in the 802.11 family . The term Wi-Fi was created by an organization called the Wi-Fi Alliance. Today, Wi-Fi can apply to products that use any 802.11 standard [7][8] .

Basically there are two types of metrics used to measure the objective quality of processed digital media: purely mathematically defined media quality metrics (DELTA, MSAD, MSE, SNR, and PSNR) where the error is mathematically calculated as a difference between the original and the processed media, and media quality metrics that have similar characteristics as (SSIM, NQI, VQM) where the perceptual quality is considered in the overall media quality estimation [9].

This paper is interested in finding the best communication channel for transferring different media files , through using different fidelity measures, specifically " mathematically quality metrics ": MSE, SNR, and PSNR.

Gonzalez and Wintz [10] showed that objective fidelity criterion can be used as a measure of system quality, as follows. If the original media file consists of (N×N) array of elements h(x,y), and the processed media file consists of (N×N) elements array of elements g(x,y). Where x,y=0, 1, …, N-1. Then the squared error (e^2) averaged over the image array is:

$$e^2=(1/N^2)\times\sum_{X=0}^{N-1}\sum_{y=0}^{N-1}[g(x,y)-h(x,y)]^2 \quad \ldots\ldots(1)$$

Then: $$MSE = \sqrt{e^2} \quad \ldots\ldots..(2)$$

The mean-square Signal-to-Noise Ratio (SNRms) of is defined as:

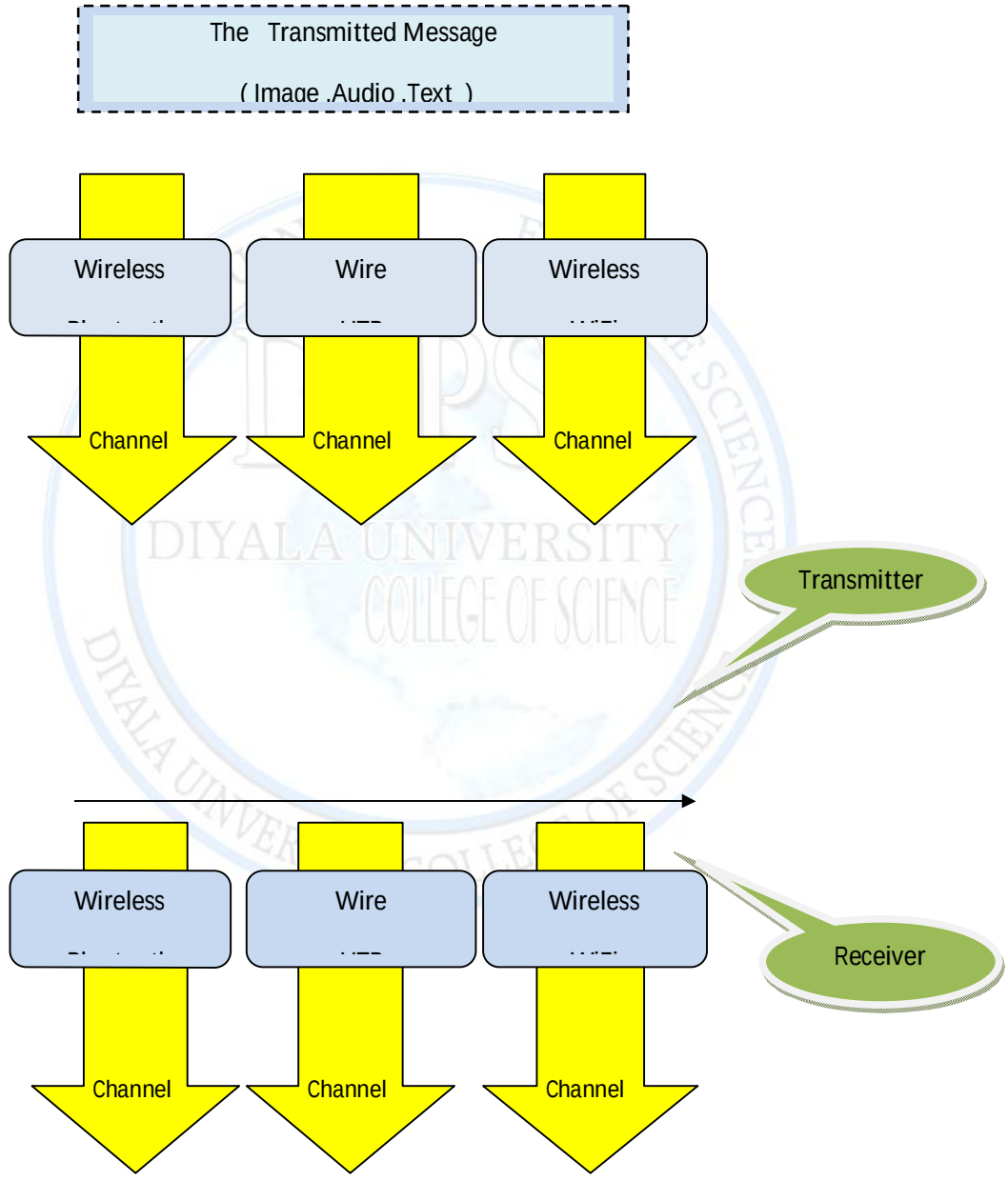
$$SNR_{ms}=\sum_{X=0}^{N-1}\sum_{y=0}^{N-1}\left((g(x,y))^2 / \sum_{X=0}^{N-1}\sum_{y=0}^{N-1}(g(x,y)-h(x,y))^2 \right) \quad \ldots\ldots(3)$$

And PSNR can be calculated as:

$$PSNR(dB) = 10 * \log(\frac{(255)^2}{MSE} \quad \ldots\ldots(4)$$

2. The Implemented System

The implemented system is shown in figure (1).



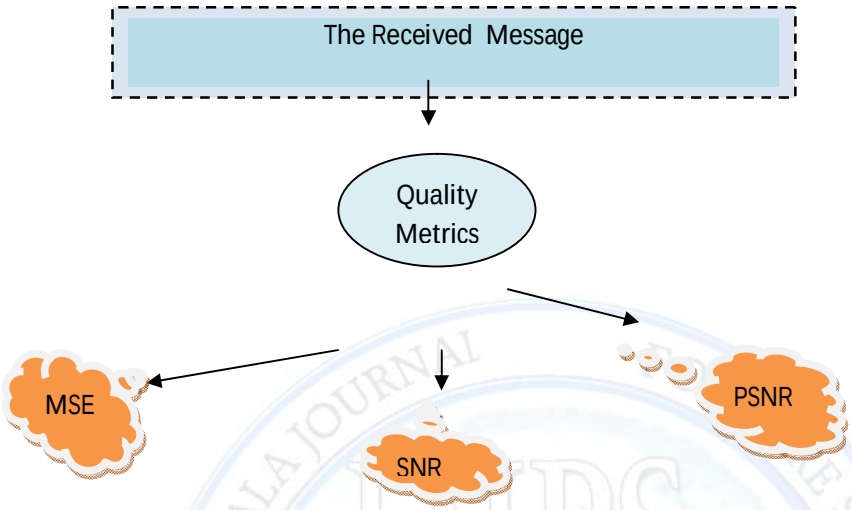


Fig. (1) The Block Diagram of The Implemented System

The implemented system transfers (image ,audio , or text) message through three types of communication channel: (UTP ,Bluetooth , or WiFi) with different distances. The bit rate and fidelity measures: (Mean Square Error(MSE)), (Single-to-Noise Ratio(SNR)), and (peak Single-to-Noise Ratio(PSNR)) are computed for each case with different distances. Then, evaluation for each case is presented.

The quality metrics (MSE, SNR, and PSNR) are calculated according to equations (1, 2, 3, and 4).

3. Results

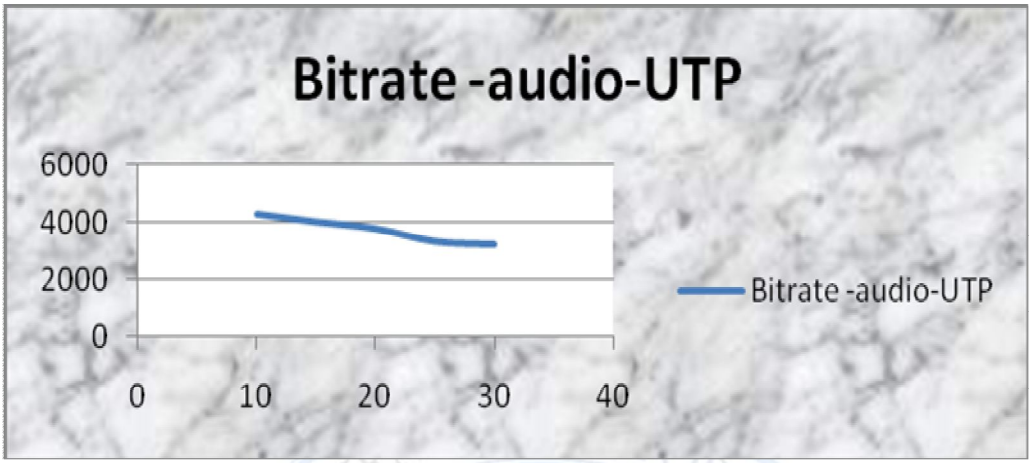
3.1 Audio file

3.1.1 UTP Channel Results

UTP channel results for transfer audio file with size (1.58 MB) are shown in table(1) and figure(1).

Table (1) UTP Results with Audio

Media	Transferred Information	Fidelity measure	Distances				
			10 m	15 m	20 m	25 m	30 m
UTP	Audio	MSE	0	0	0	0	0
		SNR	97.0956	97.0956	97.0956	97.0956	97.0956
		PSNR	undefined	undefined	undefined	undefined	Undefined
		Bit Rate	4314 kbps	4044 kbps	3806 kbps	3344 kbps	3235 kbps



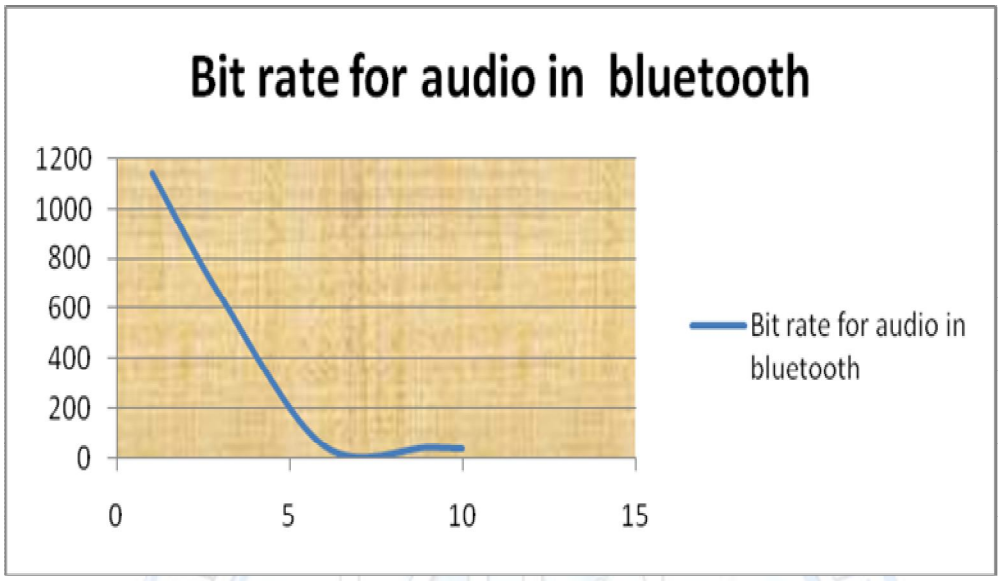
Figure(1) Relation between Bit rate and Distance for audio file in wire UTP

3.1.2 Bluetooth Channel Results:

Bluetooth channel results for transfer audio file with size (1.58 MB) are shown in table(2) and figure(2).

Table (2) Bluetooth Results with Audio

media	Transferred information	Fidelity measure	Distances				
Bluetooth	Audio		1 m	3 m	6 m	9 m	10 m
		MSE	0	0	0	0	0
		SNR	97.0956	97.0956	97.0956	97.0956	97.0956
		PSNR	Undefined	undefined	undefined	undefined	undefined
		Bit Rate	1142 kbps	647 kbps	50 kbps	44 kbps	40 kbps



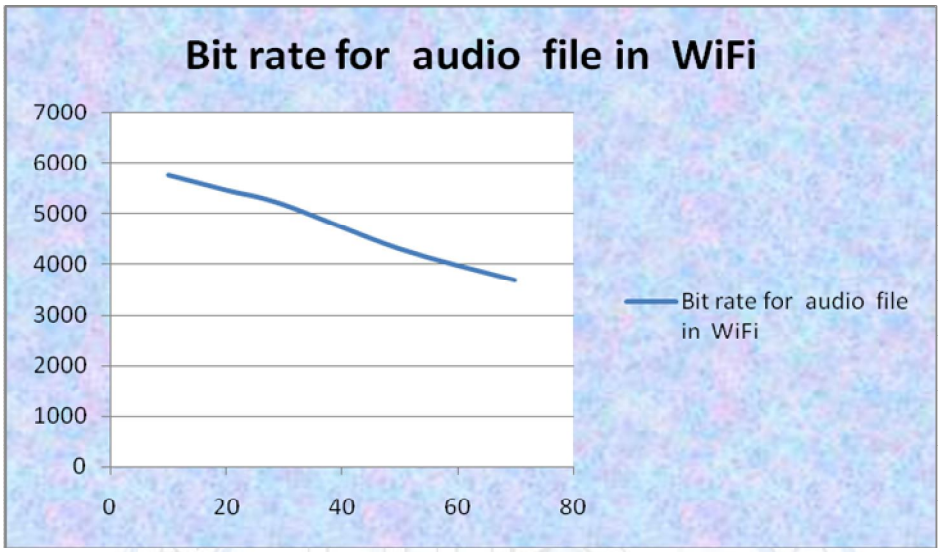
Figure(2) Relation between Bit rate and Distance for audio file in Bluetooth

3.1.3 WiFi Channel Results :

WiFi channel results for transfer audio file with size (1.58 MB) are shown in table(3) and figure(3).

Table (3) WiFi Results with Audio

media	Transferred information	Fidelity measure	Distances				
			10 m	20 m	30 m	50m	70 m
WiFi	Audio	MSE	0	0	0	0	0
		SNR	97.0956	97.0956	97.0956	97.0956	97.0956
		PSNR	undefined	undefined	undefined	undefined	undefined
		Bite Rate	5752 kbps	5461 kbps	5177 kbps	4314 kbps	3698 kbps



Figure(3) Relation between Bit rate and Distance for audio file in WiFi

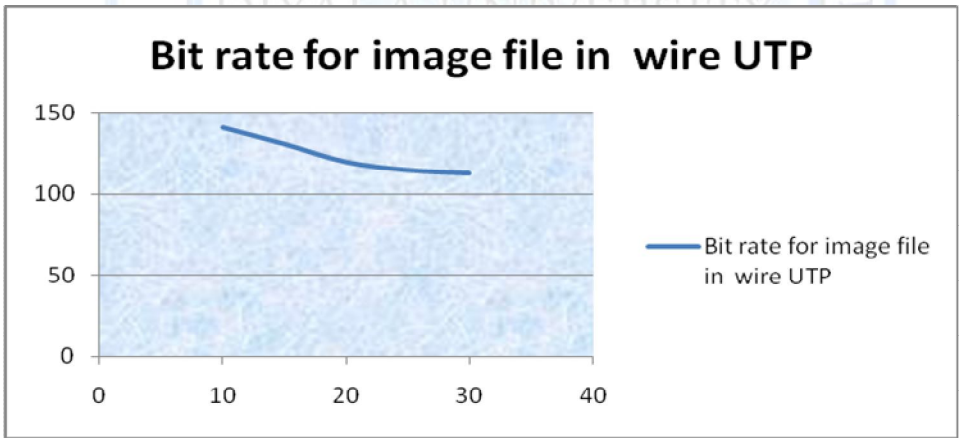
3.2 Image file

3.2.1 UTP Channel Results

UTP channel results for transfer image file with size (35.3 KB) are shown in table(4) and figure(4).

Table (4) UTP Results with Image

media	Transferred information	Fidelity measure	Distances				
			10 m	15 m	20 m	25 m	30 m
UTP	Image	MSE	0	0	0	0	0
		SNR	103.5932	103.5932	103.5932	103.5932	103.5932
		PSNR	Undefined	undefined	undefined	undefined	undefined
		Bite Rate	141 kbps	131 kbps	120 kbps	115 kbps	113 kbps



Figure(4) Relation between Bit rate and Distance for image file in wire UTP

3.2.2 Bluetooth Channel Results

Bluetooth channel results for transfer image file with size (35.3 KB) are shown in table(5) and figure(5).

Table (5) Bluetooth Results with Image

media	Transferred information	Fidelity measure	Distances				
			1 m	3 m	6 m	9 m	10 m
Bluetooth	Image	MSE	0	0	0	0	0
		SNR	103.5932	103.5932	103.5932	103.5932	103.5932
		PSNR	undefined	Undefined	undefined	undefined	undefined
		Bite Rate	126 kbps	141 kbps	108 kbps	28 kbps	20 kbps

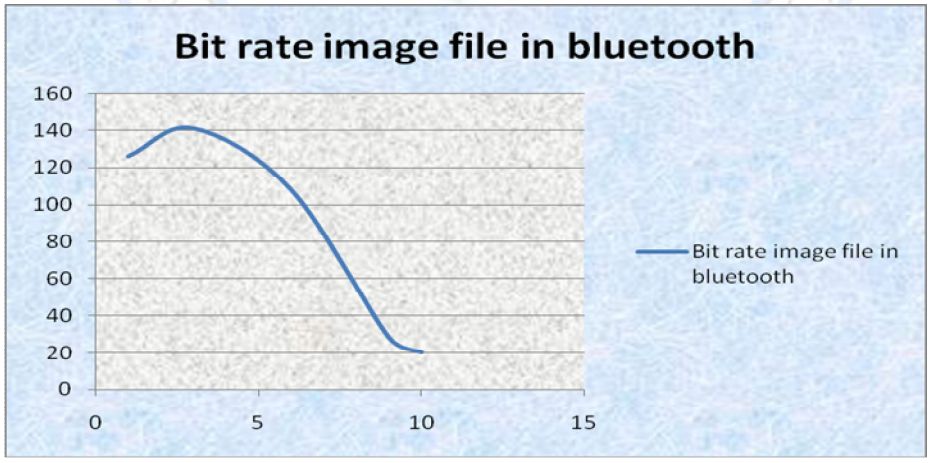


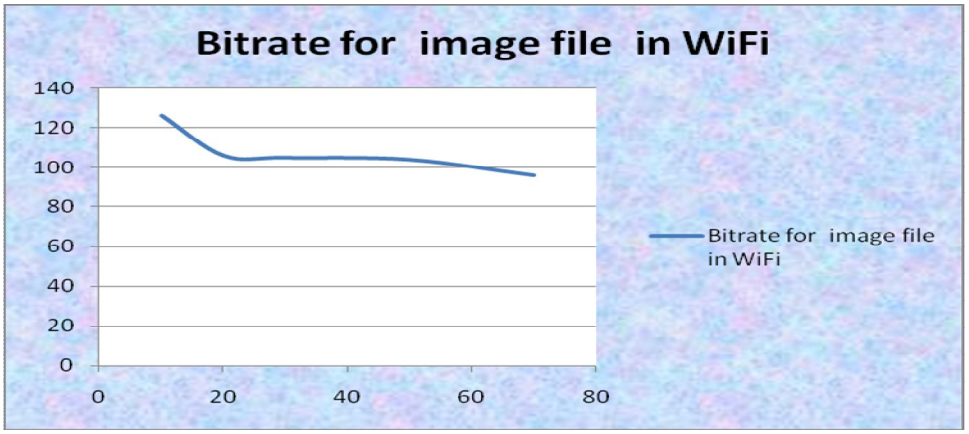
Figure (5) Relation between Bitrate and distance for image file in Bluetooth

3.2.3 WiFi Channel Results

WiFi channel results for transfer image file with size (35.3 KB) are shown in table(6) and figure(6).

Table (6) WiFi Results with Image

media	Transferred information	Fidelity measure	Distances				
			10 m	20 m	30 m	50m	70 m
WiFi	Image	MSE	0	0	0	0	0
		SNR	103.5932	103.5932	103.5932	103.5932	103.5932
		PSNR	undefined	undefined	undefined	undefined	undefined
		Bite Rate	126 kbps	106 kbps	105 kbps	104 kbps	96 kbps



Figure(6) Relation between Bit rate and Distance for image file in WiFi

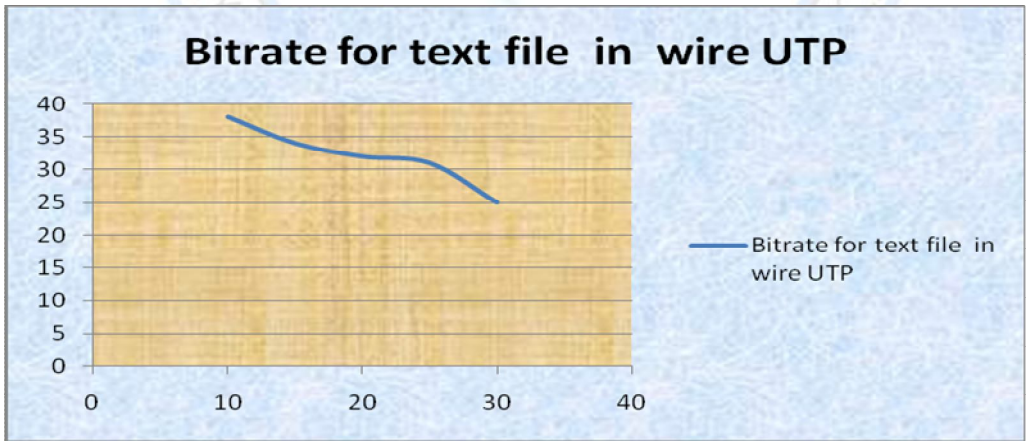
3.3 Text file

3.3.1 UTP Channel Results

UTP channel results for transfer text file with size (10.2 KB) are shown in table(7) and figure(7).

Table (7) UTP Results with Text

media	Transferred information	Fidelity measure	Distances				
			10 m	15 m	20 m	25 m	30 m
UTP	Text	MSE	0	0	0	0	0
		SNR	96.8205	96.8205	96.8205	96.8205	96.8205
		PSNR	undefined	undefined	undefined	undefined	Undefined
		Bite Rate	38 kbps	34 kbps	32 kbps	31 kbps	25 kbps



Figure(7) Relation between Bit rate and Distance for image file in wire UTP

3.3.2 Bluetooth Channel Results

Bluetooth channel results for transfer text file with size (10.2 KB) are shown in table(8) and figure(8).

Table (8) Bluetooth Results with Text

media	Transferred information	Fidelity measure	Distances				
			1 m	3 m	6 m	9 m	10 m
Bluetooth	Text	MSE	0	0	0	0	0
		SNR	96.8205	96.8205	96.8205	96.8205	96.8205
		PSNR	undefined	undefined	undefined	undefined	undefined
		Bit Rate	24 kbps	20 kbps	15 kbps	7 kbps	6 kbps

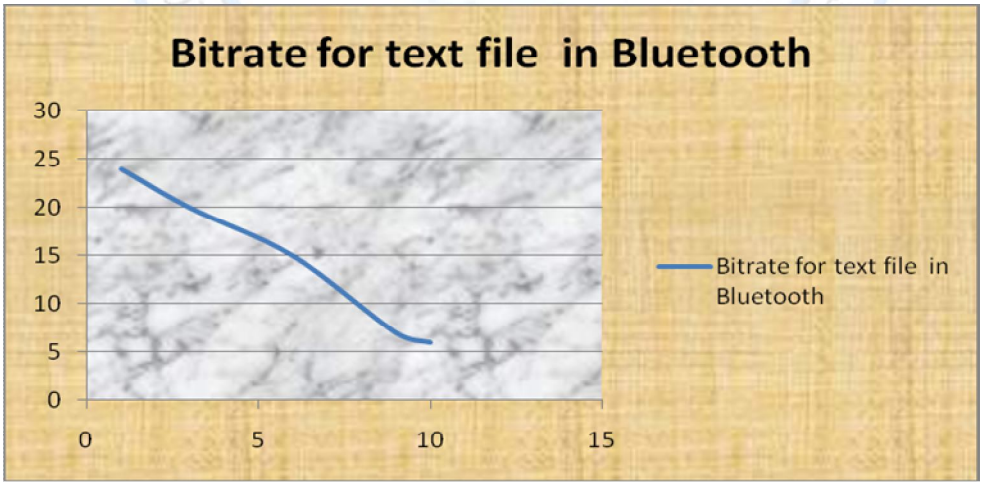


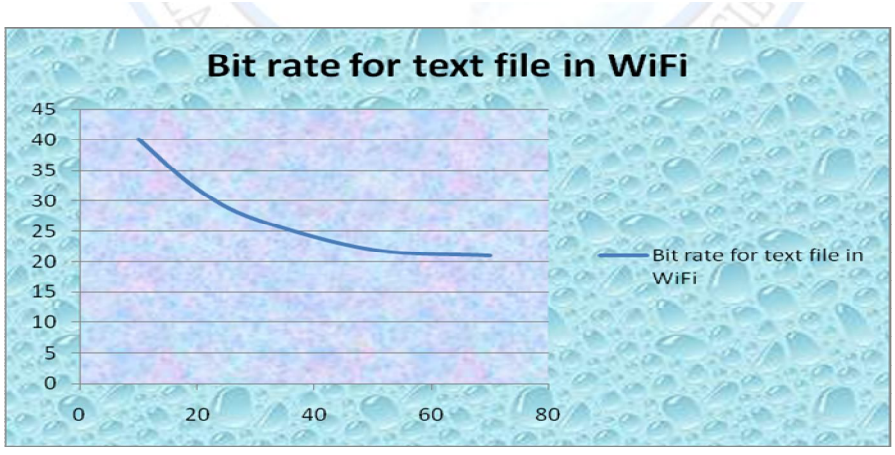
Figure (8) Relation between Bitrate and distance for text file in Bluetooth

3.3.3 WiFi Channel Results

WiFi channel results for transfer text file with size (10.2 KB) are shown in table(9) and figure(9).

Table (9) WiFi Results with Text

media	Transferred information	Fidelity measure	Distances				
			10 m	20 m	30 m	50m	70 m
WiFi	Text	MSE	0	0	0	0	0
		SNR	96.8205	96.8205	96.8205	96.8205	96.8205
		PSNR	undefined	undefined	undefined	undefined	undefined
		Bit Rate	40 kbps	32 kbps	27 kbps	22 kbps	21 kbps



Figure(9) Relation between Bit rate and Distance for text file in WiFi

4. Conclusions

1- The results in tables (1 to 9) show that (MSE, SNR, and PSNR) metrics must not taken in consideration for the transferred files without errors in transmission, i.e. they are distortion measure metrics.

2- Figures (3, 6, and 9) show that WiFi channels are suitable for transferring data with distances (30 to 100)m.

3- Figures (1, 4, and 7) show that UTP channels are suitable for transferring data with distances (1-30)m.

4- Figures (2, 5, and 8) show that Bluetooth channels are suitable for transferring small size data for short distances (1-9) m.

5- In order to transfer data for distances more than (100)m networking devices must be used with UTP and WiFi channels, such as repeaters.

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تأثير قناة الأتصال على البيانات المنقولة

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الخلاصة

يعطي هذا البحث نظرة معلوماتية عن تقنية الأتصالات من خلال ربط عقدتين حاسوبية بواسطة وسط سلكي ولاسلكي. تم أخذ (UTP) كوسط سلكي بينما تم أستخدام تقنية (WiFi) و (Bluetooth) كوسط لاسلكي. تم نقل ثلاثة أنواع من البيانات هي : النص والصوت والصورة خلال الربط المحدد، كما تم جدولة المسافة والسرعة مع قياسات الأصالة للبيانات المنقولة. تم توضيح ومناقشة النتائج العملية مع المسافات المؤثرة لكل نوع بيانات. وتم تصنيف عوامل الأصالة.

الكلمات المفتاحية : سلك الزوج الملفوف ، الشبكة المحلية اللاسلكية ، تقنية البلوتوث ، مقاييس الجودة.