Eng. & Tech. Journal, Vol. 29, No. 8, 2011

Study the Effect of Transmission Cable Resistance on Tv – Satellite Image Quality

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Received on: 30/11/2010
Accepted on: 5/5/2011

Abstract

The noise of satellite broadcasting images was statistically analyzed as a function of values of resistant put in video signal transmission cable in images adopted in the study. This was made by using a new method includes mathematically separating of the two noisy effects (additive and multiplicative) by adopting the mathematical models of noise. We have made an algorithm that includes effects separation process and finding the site statistical distribution of them for each band in the used images. In this study the contrast and edges points of the satellite images were calculated. We can note the increase resistant which put in video signal transmission cable leads to decrease in contrast and rates of edge and increase in noise.

دراسة تأثير مقاومةكيبل نقل الاشارة على جودة صور القنوات الفضائية

الخلاصة

تم تحليل ضوضاء صور البث الفضائي كداله لقيم المقاومة الموضوعة في السلك الناقل للإشارة الفديوية إحصائيا في الصور المعتمدة في البحث باستخدام طريقة جديدة تتضمن عزل المؤثرين الضوضائيين ألضربي والجمعي رياضيا وذلك بالاعتماد على الموديلات الرياضية للضوضاء. وقد قمنا ببناء خوارزمية تتضمن عملية فصل المؤثرات وإيجاد التوزيع الإحصائي ألموقعي لها لكل حزمة في الصور المستخدمة في هذا البحث تم حساب التباين ونقاط الحافات للصورالفضائية حيث نلاحظ انه بزيادة المقاومة الموضوعة في كيبل نقل الاشارة الفديوية يقل التباين ونسبة الحافات وزيادة الضوضاء .

Introduction

Composite video is the familiar type of single cable Video that has been used for many years with home VCRs (both VHS and Beta), camcorders (VHS and Video8), laserdisc players, video CD players, security cameras [1,2]. This type of video is passed from one piece of equipment to another using a single coaxial or shielded cable, fitted with the familiar RCA, or phono plugs (often color coded yellow) [3,4]. As the name suggests, composite video has all of the signal components needed to produce a TV image, combined together into a single composite signal. This means that the luminance (B&W detail) information, chrominance (color) information and sync pulses are all combined. Everything in one composite video is very convenient as a way to transport video information [5]. However because all of the components are lumped in together, it is possible for them to interact with each other if the composite signal is distorted in some

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https://doi.org/10.30684/ etj.29.8.13
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way when passing through equipment or being recorded and played back. This can result in various kinds of picture defect: (colors running outside the boundaries of their correct picture areas) , or (Moving colored interference patterns in fine picture detail) [6].

There are three main parts of a cable which affect signal quality: the conductor, the shielding, and the connector. The conductor is the part of the cable through which the signal actually passes. Since the conductor is basically a wire which can act as an antenna to receive radio frequency interference (RFI) and electromagnetic interference (EMI), a good cable also includes some kind of shielding, to filter out these potential sources of noise , types of connectors include RCA (composite video), S-video, and F-type (coaxial RF) [5].

To try and avoid the picture degradation that can occur with composite video, makers of high-end VCRs, S-VHS and Video Super-8 camcorders and laserdisc players started providing them with a different type of video output and input format. In this S-video format (sometimes called S-VHS), the chrominance information is kept separate from the luminance and sync information, to reduce the possibility of interaction. S-video signals are transferred via twin coaxial or shielded cables, which are usually fitted with miniature 4-pin DIN plugs, the signal level is and impedances are also shown in figure (1). Sometimes they are fitted with two composite video RCA-type plugs, though marked Y (for luminance plus sync) and C (for chrominance).Most video equipment fitted with S-video connectors also provided with standard composite video connectors [5].

A different kind of component RGB video is found in many of the countries in Europe, where video connections between equipment are often made using multi – way cables fitted with 20-pin SCART connectors (also called Euro connectors). This type of component video is known as RGB, because it consists of the three basic color components red (R), green (G) and blue (B).Sometimes the sync information is combined with the green video, and sometimes it is separate again. Like Y/R-Y/B-Y component video, RGB offers the potential of very high image quality, however the two types of component video are not interchangeable. Conversion circuitry is needed to change from one to the other. Note also that just because equipment is fitted with SCART connectors, this doesn’t necessarily mean it is capable of handling RGB component video. SCART connectors are actually used to convey all three types of video composite, S-video and RGB component [5]. The previous work in the effect of transmission cable resistance on TV – satellite image quality and TV image noise will be given below with a brief description to each of them

- In 2006 Radi Shadhan studied analysis of the noise associated with the recipient's digital television broadcast images of (space) and statistically significant improvement of these images depending on the digital filters with application of color spaces RGB, HLS, YIQ on these filters [7].

• In 2009 Ali Al. Zuky et al. studied TV – satellite image and analyzed to estimate their quality by using contrast of image edge method the edge of the image have the most important image information and details that describe it contents [8].

• In 2010 Shen .E.Qian studied Enhancing space – based signal to noise ratios without redesigning the satellite A newly developed signal-processing technology based on wavelets can improve the performance of satellite sensors by up to a factor of two[16]

Noise models

The success of a noise processing method depends on its ability to characterize and model the noise process, and to use the noise characteristics to differentiate the signal from the noise. Depending on its sources, a noise can be classified into a number of categories, indicating the broad physical nature of the noise as follows [9,10]:

• **The Gaussian Noise Type**

Gaussian noise takes the bell-shaped curve distribution as shown in figure(2- a), which can analytically described as [6]:

$$G(g) = \frac{1}{\sqrt{2\pi\pi^2}} e^{-\frac{(g-m)^2}{2\sigma^2}} \quad -1-$$

Where G(g) is the distribution of the random variable (g), m is the mean and σ is the standard deviation(σ^2 is variance) of (g). About 70% of all the values fall within the range from one standard deviation (σ) below the mean to one above, and about 95% fall within a distance twice the value of standard deviations. The Gaussian model is most often used to model natural noise process, such those occurring from electronic noise in the image acquisition system.

• **The Uniform Noise Type**

With the uniform distribution, the values of the noise are evenly distributed across a specific range, which may be the entire range (0 to 255 for 8-bits), or a smaller portion of the entire range. This is shown in figure (2- b), which can be modeled as [6,7]:

$$U(g)= \begin{cases} \frac{1}{(t-y)} & for \ \ y \le g \le t \\ 0 & elsewhere \end{cases} \quad -2-$$

Where: g is the random variable.

t is the ending range of random variable (g).

y is the starting range of random variable (g).

The mean (m) and the variance (σ^2) of the random variable (g) are given by:

$$m = \frac{y+t}{2} \quad ,\sigma^2 = \frac{(t-y)^2}{12} -3-$$

Uniform noise is often used to degrade images for the evolution of image denoising and restoration algorithms because it provides the most unbiased noise or neutral noise model [9].

Noise figure

Noise figure (NF) is a measure of degradation of the signal-to-noise ratio (SNR), caused by components in a radio frequency (RF) signal chain. The noise figure is defined as the ratio of the output noise power of a device to the portion thereof attributable to thermal noise in the input termination at standard noise temperature T_0 (usually 290 K). The noise figure is the difference in decibels (dB) between the noise output of the actual receiver to the noise output of an "ideal" receiver with the same overall gain and bandwidth when the receivers are connected to sources at the standard noise temperature T_0. The noise power from a simple load is equal to *kTB*, where *k* is Boltzmann's constant, *T* is the absolute temperature of the load (for example a resistor), and *B* is the measurement bandwidth[10,11].

This makes the noise figure a useful figure of merit for terrestrial systems where the antenna effective temperature is usually near the standard 290 K. In this case, one receiver with a noise figure say 2 dB better than another, will have an output signal to noise ratio that is about 2 dB better than the other. However, in the case of satellite communications systems, where the antenna is pointed out into cold space, the antenna effective temperature is often colder than 290 K. In these cases a 2 dB improvement in receiver noise figure will result in more than a 2 dB improvement in the output signal to noise ratio. For this reason, the related figure of *effective noise temperature* is therefore often used instead of the noise figure for characterizing satellite-communication receivers and low noise amplifiers. In heterodyne systems, output noise power includes spurious contributions from image-frequency transformation, but the portion attributable to thermal noise in the input termination at standard noise temperature includes only that which appears in the output via the principal frequency transformation of the system and excludes that which appears via the image frequency transformation [11].

Statistical Properties of additive and Multiplicative Noise

Noise is any undesired information that contaminates on image. The digital image acquisition process, which converts an optical image into a continuo's electrical signal then it is sampled, is the primary process by which noise appears in digital images [9,12]. Noise reduction and distortion removal are important problems in image processing and in any application where the signals can not be isolated from noise and distortion. Moreover, the noise can be identified by its statistical properties as a random function, "additive or multiplicative, correlated or un-correlated", are given by [13,14]:

$I = h \otimes R + n$ (mean of n=o)

$I = (h \otimes R) \times m$ (mean of m =1)

In practice, the most common assumption about the additive noise (n) is that: it is white "its spectral density is constant", and it is un-correlated with the image signal, and m is the multiplicative fading noise. The degradation process model consists of two parts: the degradation function . The general model in the spatial domain follows the famous expression [14,15,16]:

$$I(x,y) = h(x,y) \otimes \otimes R(x,y) + n(x,y) \quad -4-$$

where :

$\otimes\otimes$ is the two- dimensional convolution process.

I(x,y) is the degraded image, h(x,y) is the degradation function.

R(x,y) is the original image, n(x,y) is the additive noise function.

Working system

This study adopted a set of satellite images with characterizations shown in Table (1), it was registered with

Philips satellite receiver. Some satellite video clips was taken, the duration of each is 1 minutes, by Alarabiya Satellite using Nilesat satellite. The noise accompanying the satellite images was examined as a function for the resistance put in video transmission cable. We note that the increase in resistance leads to an increase in the noise accompanying the satellite images. Figure (1) shows the work operation system to acquire a clear image and images with different kinds of noise with different values of resistance. After recording the satellite video clips, these video clips were cut into scenes with 30 frame / sec and recorded as separated images by using the software Ulead video studio 10. Thereafter, one image of each satellite video clips was chosen, taken with a specified resistance (75, 125, 150, 200) Ω. This was saved in Bitmap format. We note that the more the resistance put in the video transmission cable, the more the noise is. The images of satellite broadcasting as a function of the resistance put in the video signal transmission cable.

TV – image Histograms

By visual testing for the Tv image in figure (4) we notes that the visibility gradually decreasing from images when the resistance which place in the cable signal video , that is perfectly identical with the histograms of these images, as shown in figure (5), which illustrates the histograms of the intensity level distributions for (RGB-L) components of each image. It seems from this figures that the noise increasing gradually with increase resistance. This shown where one sees the peaks are gradually slow down and their width increases.

Histogram of additive and multiplicative noise operators

The figure (6) illustrates the distributions of the additive noise from the TV. Images and figure (7) illustrate the distributions of the multiplicative noise. It can be shown from the figures of the noisy parameters distributions for all RGBL and the RGB peaks gradually decreases and become wider when cable resistance increased i.e. increase noise.

Edges rate calculation of satellite image

The relation between edges rate of different images with different values of resistant put in video transmission cable, using different threshold for Soble operator(th = 20,40,60,80,100), was examined. Their results are indicated in figure (4) for the RGB complex and lighting complex. We note that the increase in resistant values lead to decrease in edges rate in satellite images.

The noise of satellite broadcasting images was statistically analyzed as a function of values of resistant put in video signal transmission cable in images adopted in the study. This was made by using a new method includes mathematically separating of the two noisy effects (additive and multiplicative) by adopting the mathematical models of noise. We have made an algorithm that include effects separation process and finding the site statistical distribution of them for each band in the used images. In this study the contrast and edges points of the satellite images were calculated. We note that the increase in put in video signal cable the increase in resistant put in the video signal transmission cable leads to decrease in contrast edges rates and increase in noise.

Contrast Technique adopting the statistical characteristics

In these technique statistical characteristics of edges points were adopted to calculate the contrast from contrast equation [17]:

$$\frac{I_{max} - I_{min}}{I_{max} + I_{min}} \qquad -5-$$

I_{min} and I_{max} were calculated adopting the edges points average (μ) and the standard deviation (σ) according to the following relations [17]:

$I_{min} = \mu - \sigma$ and $I_{max} = \mu + \sigma$

After replacing I_{min} and I_{max} in the above equation the equation will be as follows:

$$\frac{(\mu + \sigma) - (\mu - \sigma)}{\mu + \sigma + \mu - \sigma}$$

$$\therefore c = \frac{\sigma}{\mu}$$

This technique has a high efficiency in contrast determination, since it take into account all edges points. Figure (9) shows the relation between contrast and threshold of Soble operator of satellite images with different values of resistance put in the video transmission cable for the red, green and blue color bands and lighting complex L. We see, in the figure, that while the values of resistance put in the video transmission cable increase, the contrast decreases.

Conclusion

In this study TV- satellite images have been analyzed by using statistical calculations to determine characteristics of the TV-image noise. From the results of the present study the were concluded From the RGB-L histogram curve of the images, there is gradual decrease in the height of peaks of the curve with the increase of the resistance of video signal cable for RGB-L components. This means that the noise has equal effect on RGB-L components. When the video signal cable resistance increases the video of the signal distorted and this distortion appear as noise on TV-images. The distribution of additive and multiplicative noise operators not symmetrical .

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Table (1)the channel characteristic of Tv – used

Frequency	11.938GHz
Symbol rate	5275
Polarization	vertical
Strength	80
Quality	98

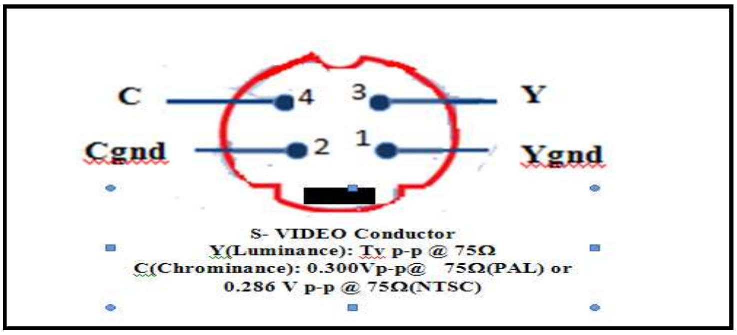


Figure (1) The Pin Connections for the 4 – Pin mini DIN connector used for most S – video cables [5]

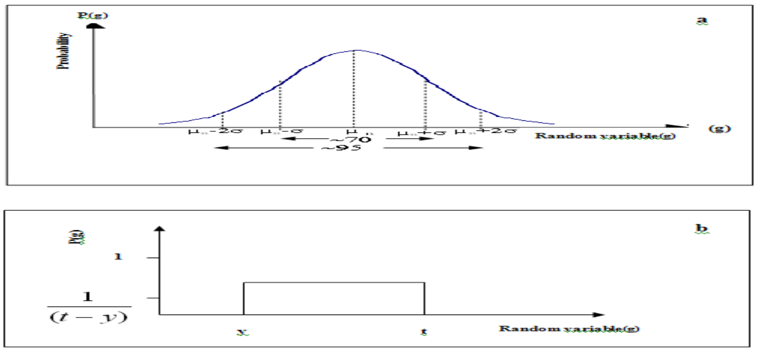


Figure (2) a- Gaussian distribution b- Uniform distribution[6]

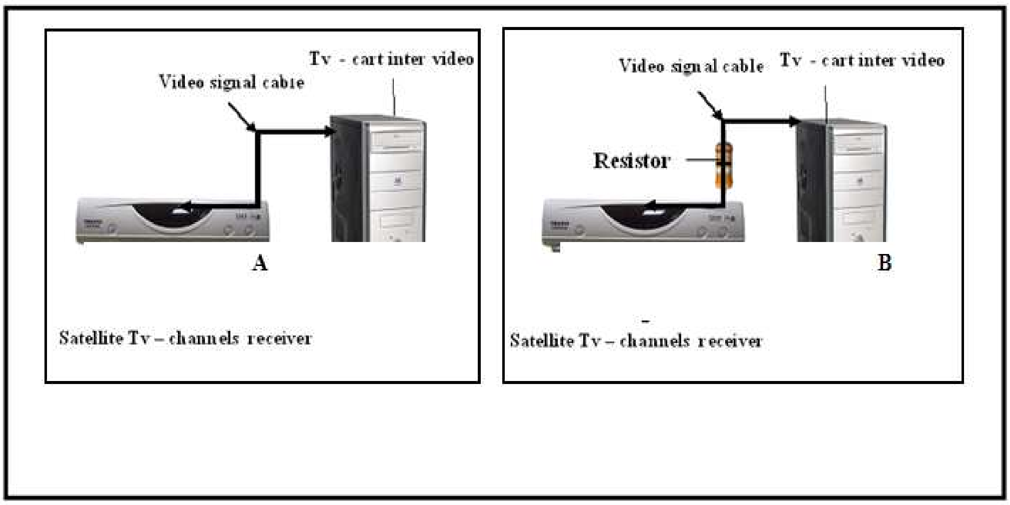
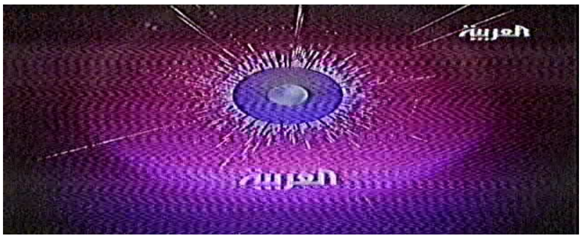
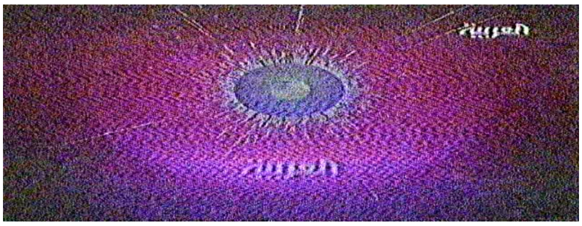


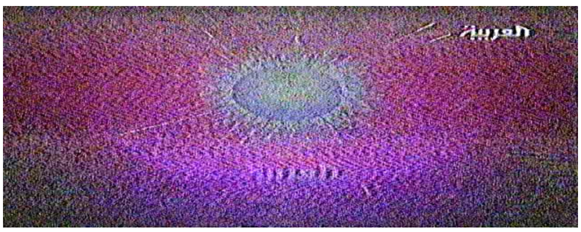
Figure (3) system working

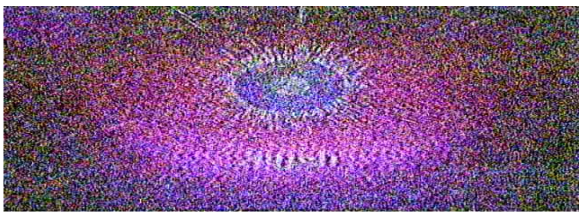
Image original





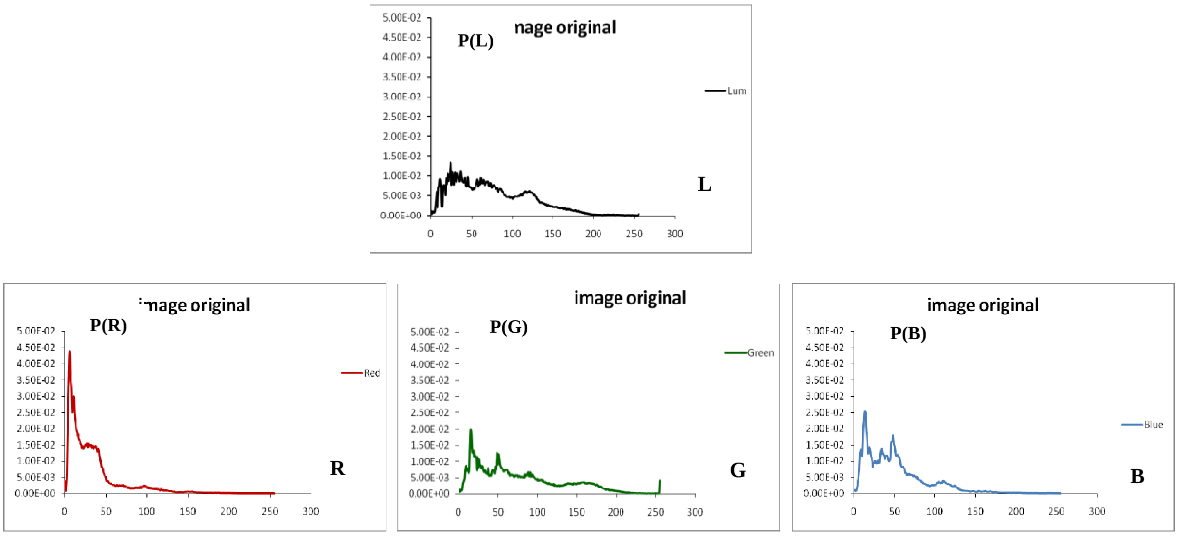
R =75 Ω **R =125 Ω**



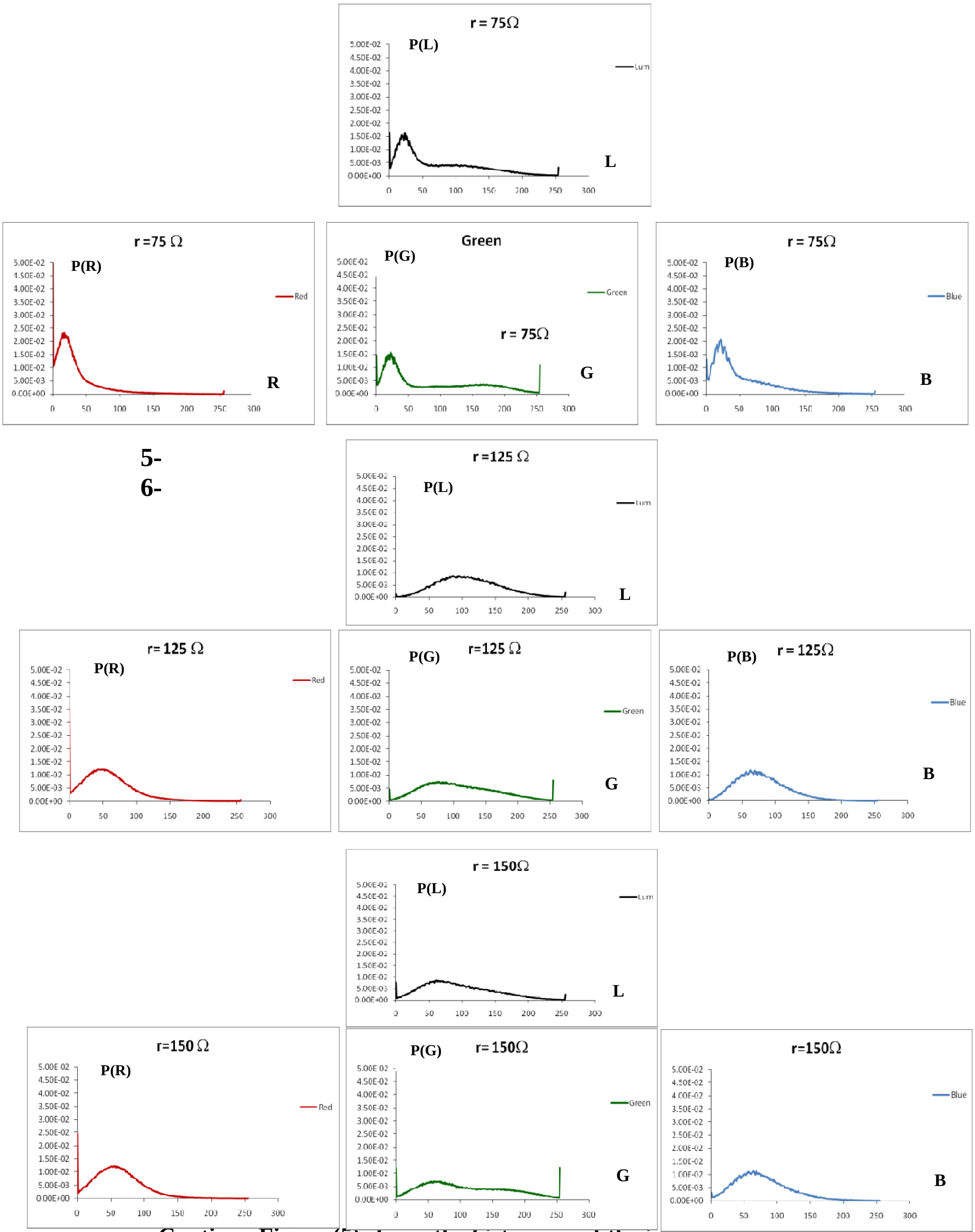


R =150 Ω **R =200 Ω**

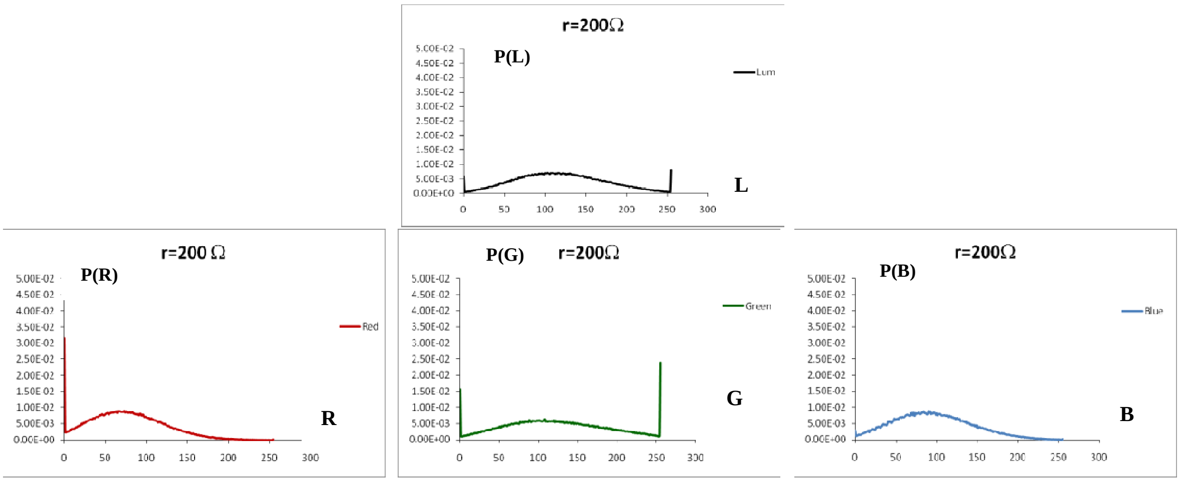
Figure (4) shows the images used in this study, extracted from Aarabya - Tv satellite channel for different resistance



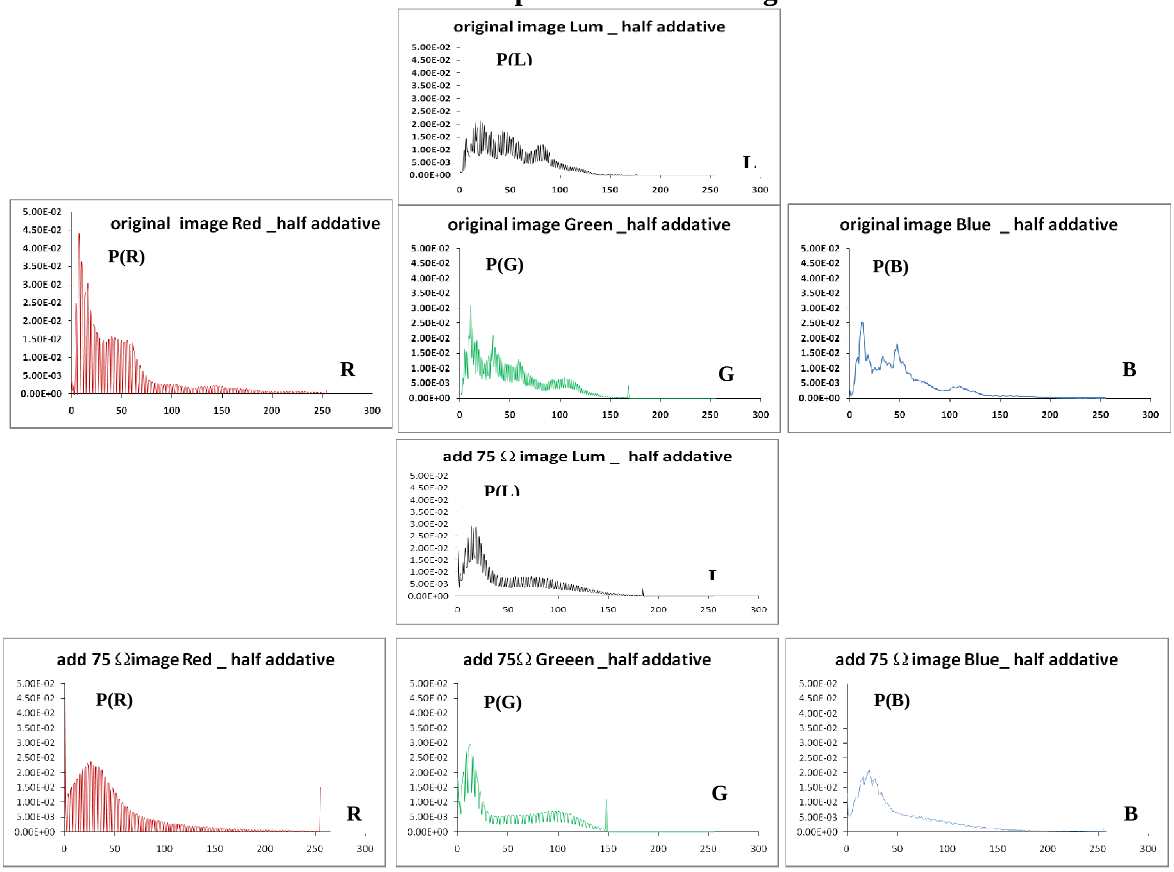
Figure(5) shows the histogram of the image original and image which used resistance75Ω in the cable signal transfer video for (L-RGB) components of each image



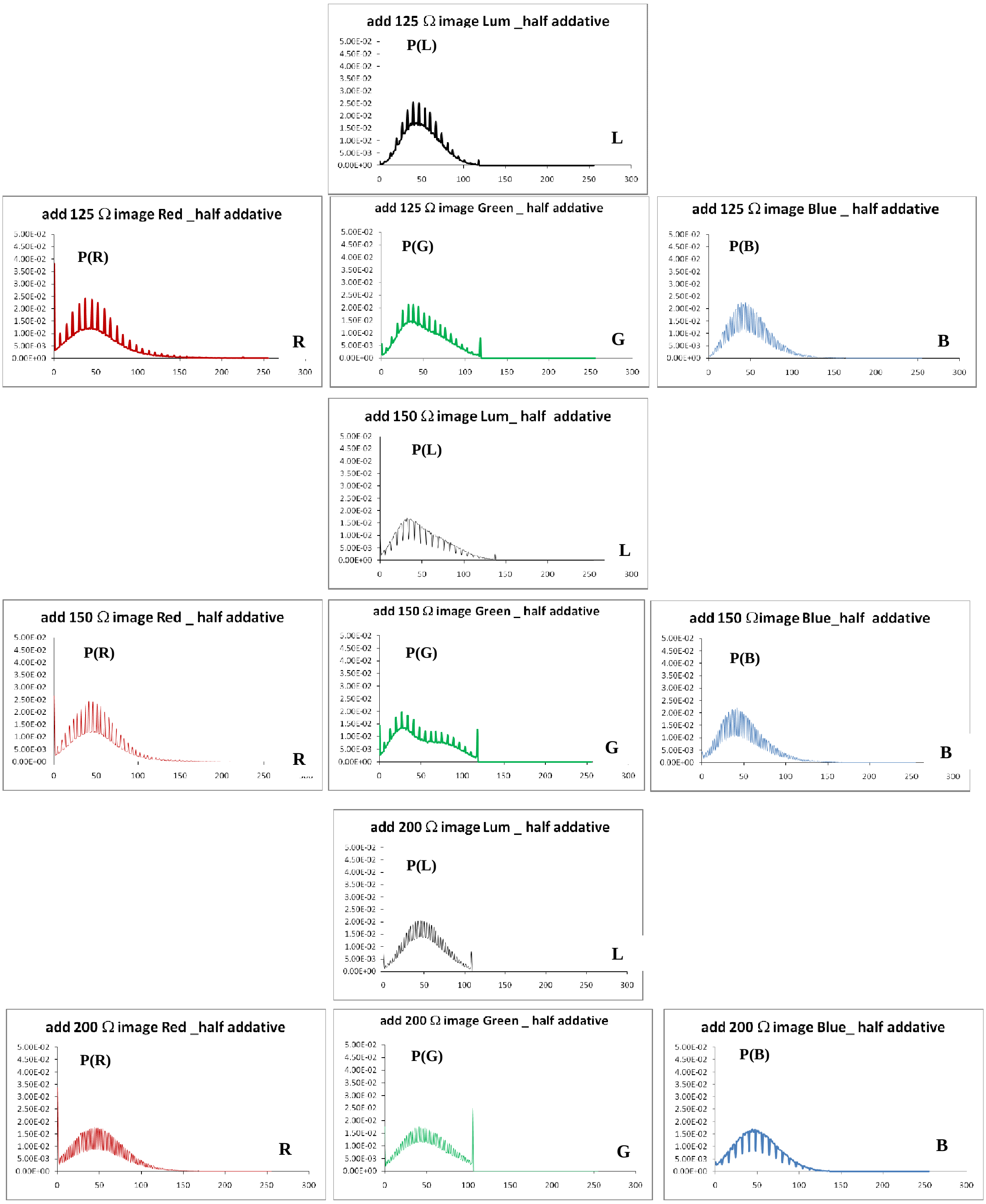
Continue Figure (5) shows the histogram of the image which used resistance(75,125,150)Ω in the cable signal transfer video for (L – RGB) component of each image



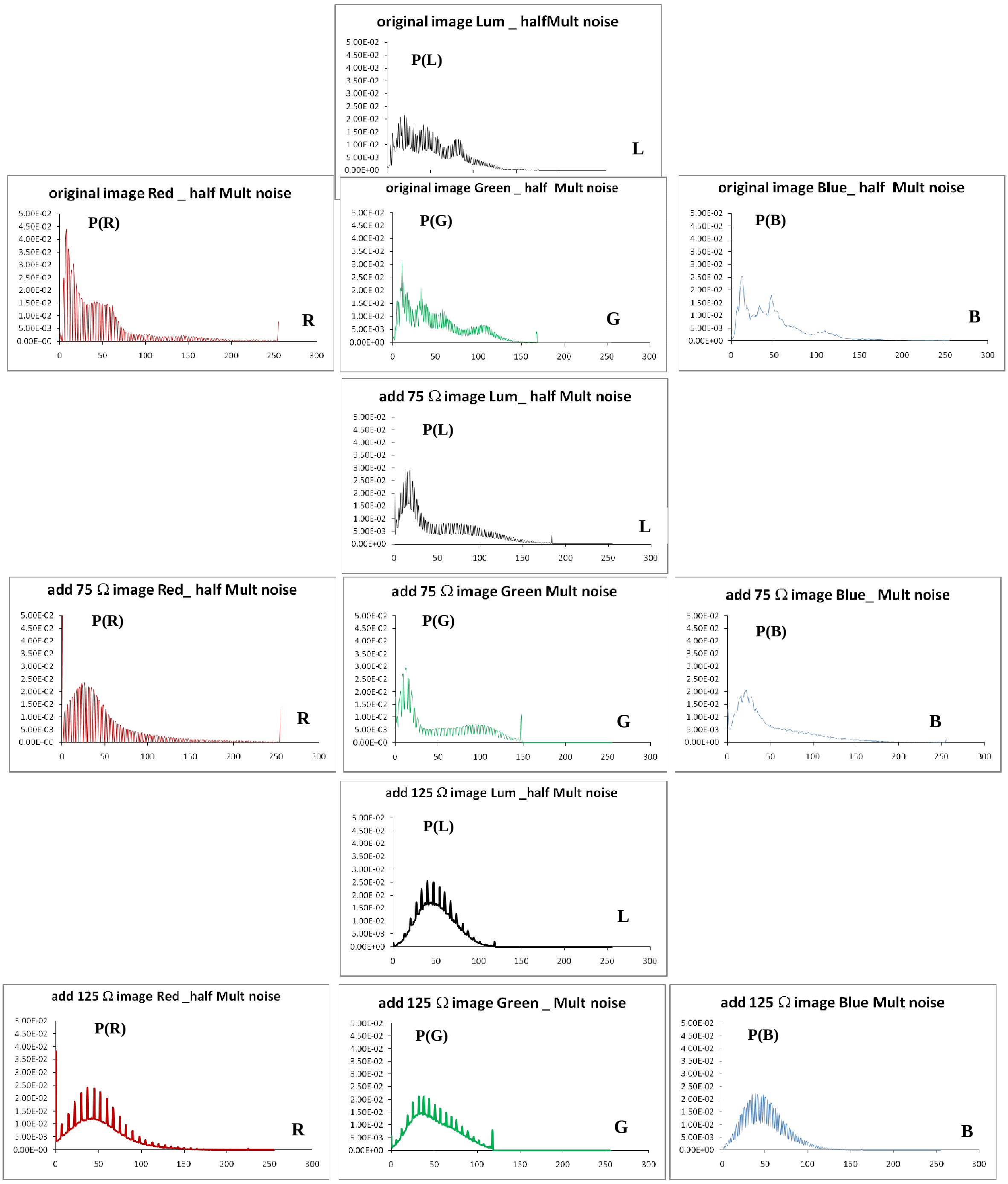
Continue Figure(5) shows the histogram of the image which used resistance(200)Ω in the cable signal transfer video for (L-RGB) components of each image



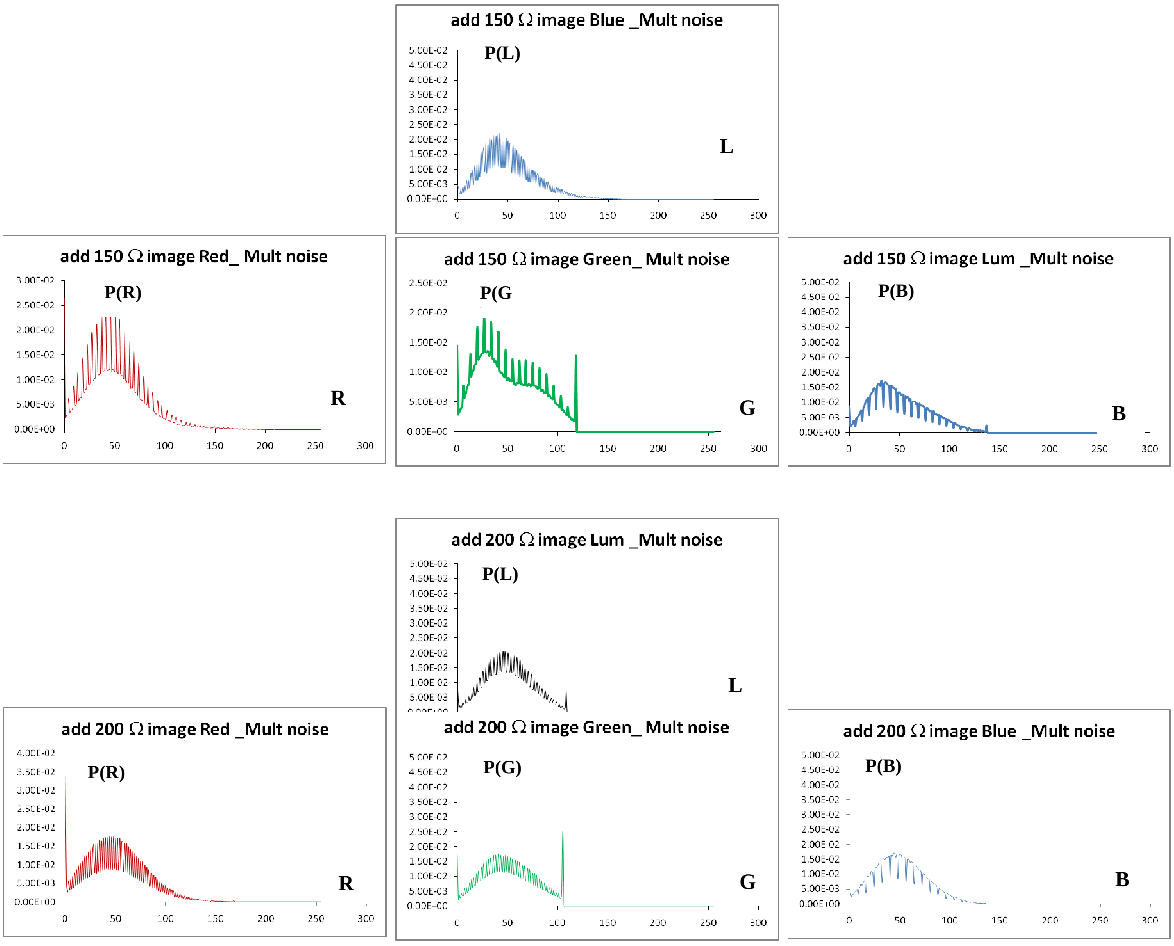
Figure(6) shows the histogram to half additive noise of the image original and image which used resistance75Ω in the cable signal transfer video for (L-RGB) components of each image



Continue Figure(6) shows the histogram to half additive noise of the image which used resistance(125,150, 200)Ω in the cable signal transfer video for (L-RGB) components of each image



Figure(7) shows the histogram to half multiplicative noise of the image original and image which used resistance(75,125)Ω in the cable signal transfer video for (L-RGB) components of each image



Continue Figure(7) shows the histogram to half multiplicative noise of the image which used resistance(150, 200)Ω in the cable signal transfer video for (L-RGB) components of each image

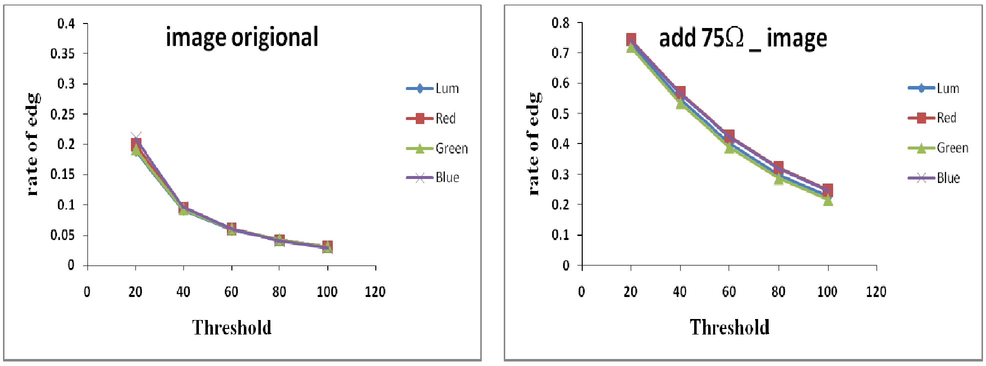
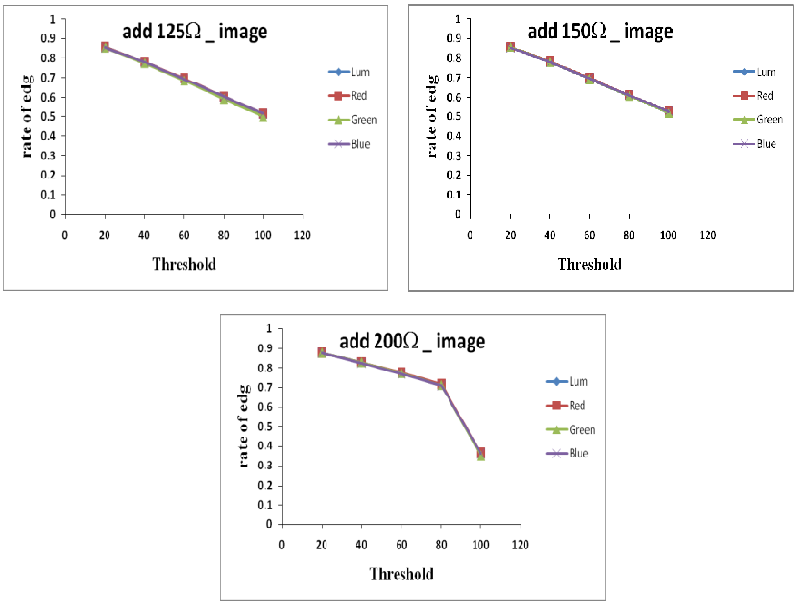


Figure (8) shows the rate of edge point of the original image and different image which used resistance(75,125,150, 200)Ω in the cable signal transfer video for (L-RGB) components of each image for different threshold



Continuo Figure(8) shows the rate of edge point of the original image and different image which used resistance(75,125,150, 200)Ω in the cable signal transfer video for (L-RGB) components of each image for different threshold

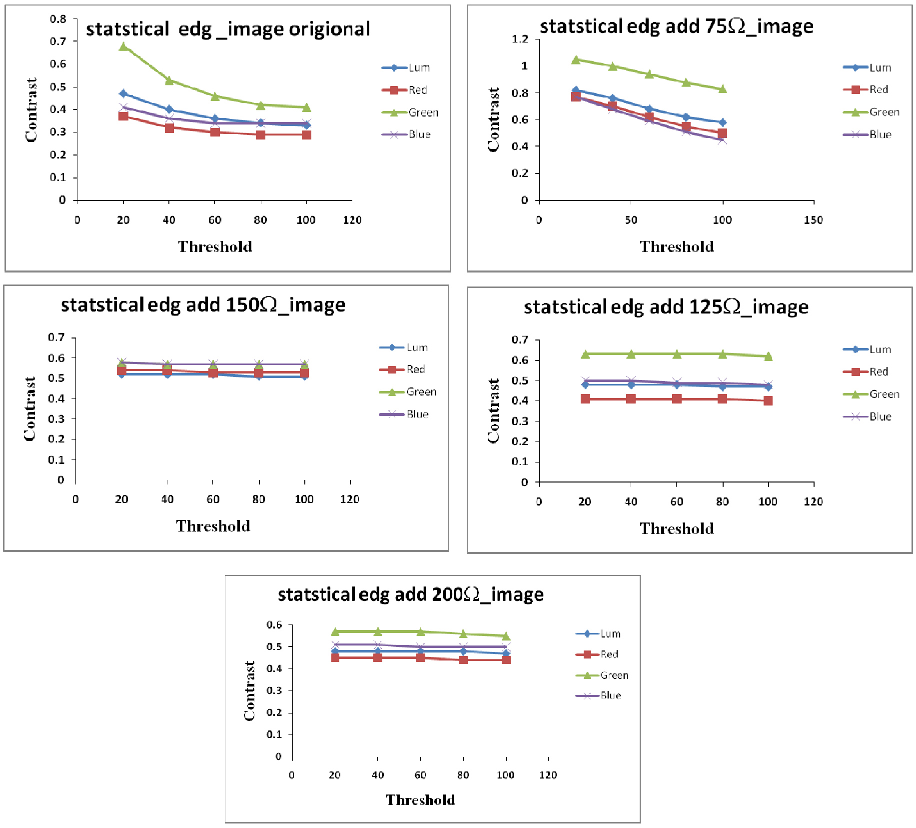


Figure (9) shows the contrast value of the original image and different image which used resistance(75,125,150, 200)Ω in the cable signal transfer video for (L-RGB) components of each image for different t