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# DESIGN OF A SIGNAL CONCENTRATING ANTENNA FOR A LAP-TOP

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**ABSTRACT**

The use of wireless nets actually offers a great amount of services that operate through the internet and to be able to connect to one of them it is necessary to be within a delimited zone in order to obtain an optimus signal reception, but you can't always be in the same place and mobility causes a decrease in the intensity of the signal, that is why this work, proposes to design an antenna that will capture, concentrate and redirect the signal toward the tablet or net card of a laptop increasing and improving the signal reception.

**Key words:** *Antenna, Fractal, Laptop, Signal Intensity, Net Card And Coupling*.

## 1. INTRODUCTION

Now a days the use of wireless nets is very common all over the world but exists a big problem that affects directly the signal intensity, specially in a laptop, the wireless nets work by radio frequency and these may be affected by objects, construction elements, some others sources of radio frequency, by climate and its changes, surfaces that diminish or decrease the covering or just by simply moving to another place. That is why it is necessary to couple a complement to the net card with the intention to concentrate a greater amount of the signal and that it redirects it in order to be shrewd by the card, increasing the intensity of the laptop signal avoiding that it decreases to such a point that the connection is lost.

The antenna proposed was designed as if it were a sticker so that it may be adhere to the laptop, besides, the patch antenna technology was used with a coupling by proximity.

Antenna Definition
An antenna is a transductor device [1][5] formed by a joint of conductors that, along with a generator allow the radio frequency wave emission by the free space or that connected to an impedance is desirable to capture the waves send forth by a far source.

## 2. MICROTAPE ANTENNA

A micro-tape [3][6][2] is a fine electric conductor separated plane ground by an isolated layer (dielectric substract). The micro-tapes are used in designs for printed circuits where the high frequency signals need to be directed or set out for the required application.

The micro-tape antennas can be used like transmitters or receptors with their functioning based on the microwaves identified in the rate of frequencies understood between 1 GHz and 300 GHz and denominated also as milimetric waves by their length wave in the order of millimeters [4].

This type of antennas are very practical due to their easy manipulation and handle, lithographic techniques may be used or some other one that suits the designer´s needs. The basic form of construction for a micro-tape antenna may be described as follows:

- A very thin conductor surface called patch or plaster
- Dielectric substract
- If it is a transmitting antenna, a power source, which supplies the RF to the element

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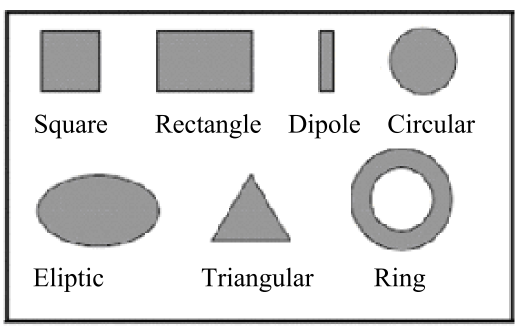
Fig. 1 Representation of a micro-tape fractal antenna.

We may say that a fractal antenna has the following principal characteristics:

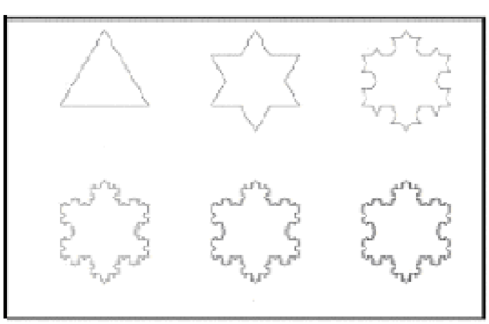
- A great band width and a multiband behavior
- In the majority of the cases, they have a considerable gain depending on the frequency range that embraces

## 3. PATCH TOPOLOGY

The patch conductor [7] may be variable depending on the great amount of existing topologies to simplify the analysis and the prediction of the fulfillment. See figure 2.




a)



b)

Fig. 2 Topologies of the conductor patch

Advantages and disadvantages of the micro-tape antennas [7]

**Advantages:**

- Light and small volumen
- Plane profile, which makes easier their adaptation to any surface
- Low manufacturing cost and easy to make in series
- May be designed to work at different frequencies

**Disadvantages:**

- Have limited power
- Work specifically in a designed frequency

## 4. COUPLING TECHNIQUES

There are various methods to couple the micro-tape antennas, these methods are classified in two categories:

- Contact
- Null or void contact

In the contact methods, the radio frequency power is transferred or run through directly to the patch by the use of connective elements such as the micro-tape lines.

The null on void contact methods are based in the transference power through the coupling fields.

For the design of this antenna one of the null or void contact methods was used, the proximity coupling.

In the proximity coupling the transductor is integrated near the device which is pretended to complement but without any physical connection between them. This technique has the advantage to eliminate undesirable radiations proceeding from the power supply and at the same time provides an ample band width.

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## 5. DESIGN OF THE CONDUCTOR PATCH

In order to design the antenna its necessary to have very clear the application that we want to implement besides this, the frequency operation at which it is going to operate, the dielectric material that is going to be used, the dielectric constant of this material and the width of the same to be able to calculate the patch dimensions.

### Calculation Methods and Analysis

The analysis of the micro-tape antennas for its later design is done through models that simulate their behavior. The most popular are:

- Model by transmission line
- Model by cavity
- Model of complete wave

The one used for this antenna was the model by transmission line due that its simple and proportions a good physical interpretation of what occurs.

### Length and Width of the Patch

The width of the patch is given by the following equation:

$$W = \frac{c}{2f_0\sqrt{\frac{\varepsilon_r + 1}{2}}} \qquad (1)$$

Where $c$ is the velocity of the light $\varepsilon_r$ is the dielectric constant of the material used and $f_0$ the operation frequency.
To calculate $\varepsilon_{eff}$ that is the effective dielectric constant of the material, equation 2 is used.

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\left(\frac{h}{W}\right)\right]^{-0.5} \qquad (2)$$

To calculate $L_{eff}$ that is the effective length of the patch, equation 3 is used.

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{eff}}} \qquad (3)$$

Through empirical results an extension of the patch was determined ΔL. This extension is given by:

$$\Delta L = 0.412h\left[\frac{\left(\varepsilon_{eff} + 0.3\left(\frac{W}{h} + .264\right)\right)}{\left(\varepsilon_{eff} - 0.258\left(\frac{W}{h} + .8\right)\right)}\right] \qquad (4)$$

To calculate the real construction length of the patch we obtain it by equation 5

$$L = L_{eff} - 2\Delta L \qquad (5)$$

Finally the dimensions of the dielectric substract are calculated that is, the material where the conductor patch rests and for that the equations (6) and (7) are applied.

$$L_g = 6h + L \qquad (6)$$

$$W_g = 6h + W \qquad (7)$$

Next the form of the patch is presented previously obtaining its dimensions.

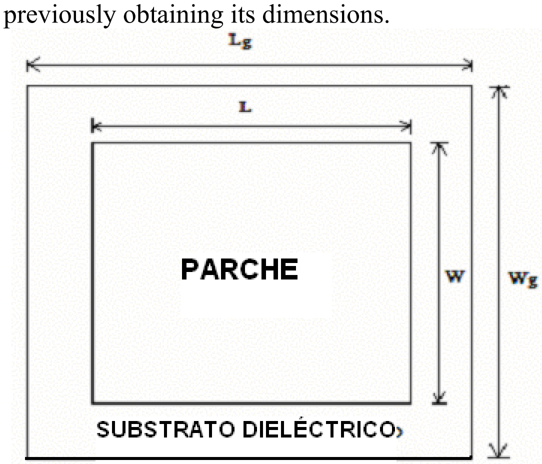


Fig. 3 Measures of the conductor patch

For the design of the proposed antenna some interactions of two types of fractal antennas were realized taking in mind the length and width previously obtained, these will be: Sierspinski Triangle and Koch Curve.

To construct both proposals a triangle like the one shown in figure 4 is constructed.

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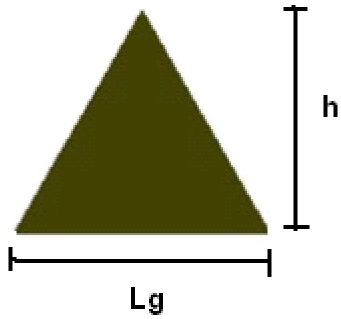


Fig. 4 Triangle base for both types of antennas.

To calculate the height of the triangle you should follow equation 8

$$h = \frac{L_g + 2}{2} = \frac{L_g}{2} + 1 \quad (8)$$

After obtaining the equilateral triangle you extract the triangle formed by joining the middle points of the original triangle just like it is shown in fig. 5.

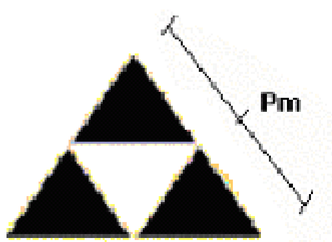


**Fig. 5 Iteraction of the Sierspinski Triangle**

To calculate the middle or center point of each side of the equilateral triangle, use equation 9.

$$P_m = \frac{L_g}{2} \quad (9)$$

To design the Koch Curve its necessary to add an equilateral triangle with the same dimension as the first one according to fig. 6.

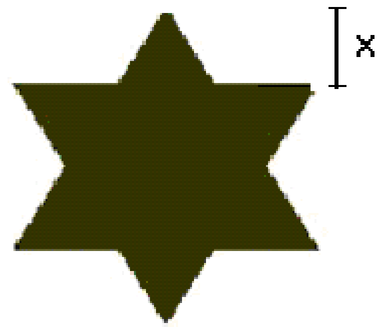


Fig. 6 Iteraction of the Koch Curve

At last to calcúlate the space "*x*" among the triangles, use equation 10.

$$X = \frac{h}{2.875} \quad (10)$$

Physical Design of the Antenna

Begin from the initial data to realize the calculus. First stablish the operation frequency of the net card of a laptop which is of 2.4 GHz, the substract to use is the mica since it is an economic and easy to obtain material, and its dielectric constant is 5.4 and the last step is the measurement of the width of the dielectric material, the mica, that was of 0.2 mm.

Employing the equations before mentioned, the following results were obtained:

Results Obtained

$$\begin{cases} W = 34.9385\ mm \approx 35\ mm \\ L = 26.34332\ mm \approx 26\ mm \\ L_g = 27.54332\ mm \approx 28\ mm \\ W_g = 36.13856\ mm \approx 36\ mm \end{cases}$$

For the iteractions of the Sierspinski Triangle and the Koch Curve the following measures were obtained:

Resultados Obtenidos

$$\begin{cases} h = 2.4cm \\ P_m = 14mm \\ X = 0.8cm \end{cases}$$

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## 6. IMPLEMENTATION

The net card before mentioned is found near the top or hard cover of the laptop and of the battery just as the wave guide of the card, therefore the proposed antenna was set near these parts of the laptop.


Fig. 7 Photo of the net card and the wave guide of a laptop

As it was mentioned before the best place to set the antenna is inside the laptop´s battery as you may see in figure 8.


Fig. 8 Photo of the fractal Antenna implemented in the laptop

## 7. TESTS AND RESULTS

Before realizing the correspondng tests with the designed antennas, a withdrawal distance to the access point was proposed of approximately 15 m, that is the distance where it was notable the disminution of the signal intensity. The figure 9 shows de characteristic curve of such decrease.

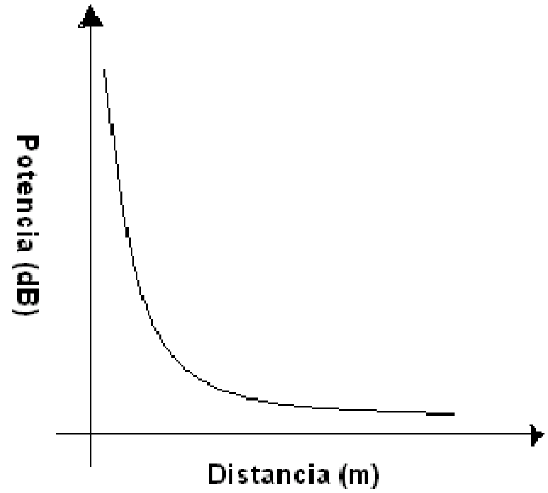


Fig. 9 Diminution of the potency in order to the distance

Besides, it should be mentioned the climate of Mexico City the day the tests were done, because as it is known the more cloudy it si the greater the attenuation of the signal.


Fig. 10 Climate in Mexico City the day of the tests

After that, the intensity of the signal of the wireless net named “Antonio” was measured without implementing the designed complement and the results obtained are shown in fig 10.

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Fig. 11 Intensity of the signal of the net "Antonio" without the antenna

At last the results were measured with the designed fractal antennas and this is what was obtained:


Fig. 12 Intensity of the signal of the net "Antonio" with the fractal antenna set

## 8. RESULTS OBTAINED

The next table shows the comparison of the obtained results:

| Type of Antenna | Signal percentage before setting the antenna | Signal percentage after setting the antenna |
|---|---|---|
| Sierspinki Triangle | 76% | 87% |
| Koch Curve | 76% | 87% |

## 9. CONCLUSIONS

The design of the antenna is relatively simple concerning the realization of the calculation, only that at the moment of realizing the design physically, its necessary to be very precise in measurements and cuts due that they have to be the most exact.

In both designs the increase was considerable and the same. A micro-tape antenna has many advantages, comparing to other types of antennas that work at the same frequency, since they are light and with small volume, besides their easy installation and attractive design.

Before implementing or setting the antenna the dust and impurities must be wiped away with a lightly damp cloth and trying not to touch with the finger tips the antenna dielectric, since this may hinder its development.

## REFERENCES

[1] WAYNE, Tomasi, *Sistemas de comunicaciones electrónicas*, Prentice Hall, México, 1996

[2] KRAUS, Jhon, *Antenas,* Mc Graw Hill

[3] CARDAMA, COFRE, RIUS, ROMEU, BLANCH, BATALLER, *Antenas*, Alfaomega, México, 2004, pp. 110-112, 334-335

[4] MIRANDA, José Miguel, Ingeniería de Microondas Técnicas Experimentales, Prentice Hall, 2002, pp. 243-250

[5] SOSA Pedroza, Jorge Roberto, Radiación Electromagnética y Antenas, Limusa, pp. 107-124

[6] SAUNDERS R., Simon, Antenas and Propagation for Wireless Communication Systems, Wiley, 1999, pp. 83-84

[7]http://antenared.com/2009/02/antenasmicrocinta-o-patch-caracteriticasbasicas/