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Traceability and Inventory Online by Integrating GPS and RFID in a Geographic Information System ¨GIS¨

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Abstract

In this research we are are going to study Traceability and Inventory Online, as well as the fundmental Communication and Electronic Theory for a System for Geographic Information (GIS) integrating GPS and RFID in an APRS-net. The Traceability Concerns to the possibility to obtain the Quantification and the GeoReference from a Subject or Object in Real Time in a Safe, Simple, Scalable, Efficient, and Economic Way. It is our interest also set in this installment the Essential Electronics on the Design of a Digital System FM Stereo for the Transmission and Reception of the RFID and GPS Frames for Layout of Transceiver Radio Frequency Interoperating in a GIS which enables Traceability and Inventory at any Time and from Anywhere.

Keywords: RFID - GPS Traceability; APRS-net; Communications Basic; Stereo System Interoperation Design.

1. Introduction

The Data Transmission in a Real Time ¨zero cost¨ is a System called APRS-Automatic Packet/Position Reporting or System for Automatic Information of Position, it is allows links for integrating GPS and RFID, within a Geomatics-Education - Business Model. It is established as an integrator for traceability monitoring Gate as well as for small business Enterprise economic and effectively. The APRS has been a technology that combines the use of Digital Maps for positioning in Stations and Objects, using an Open and Transparent System based on Radio packages (AX.25) Mode. This System is used as a Means for a Viral Communication using Radio Waves through Radio-Diffuser or through an integrated Satellite link by Local Radio Broadcasting Antennas.

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1.1. Global Connectivity with APRS-GSM-GPRS

The Communication System for Sending and Receiving Data from the GPS and RFID is designed through a Direct Sequence Spread Spectrum System (DS/SS) [1], where the Data are introduced as way to Serial Multiplexed (t) b, this, within a Spectrum of our Communication Process ¨Representation¨.

In Figure 1; Let's look at the Architecture of the Structure of Communication's Family of Systems APRS-GSM-GPRS and the direction of the Flow of Information they generates.

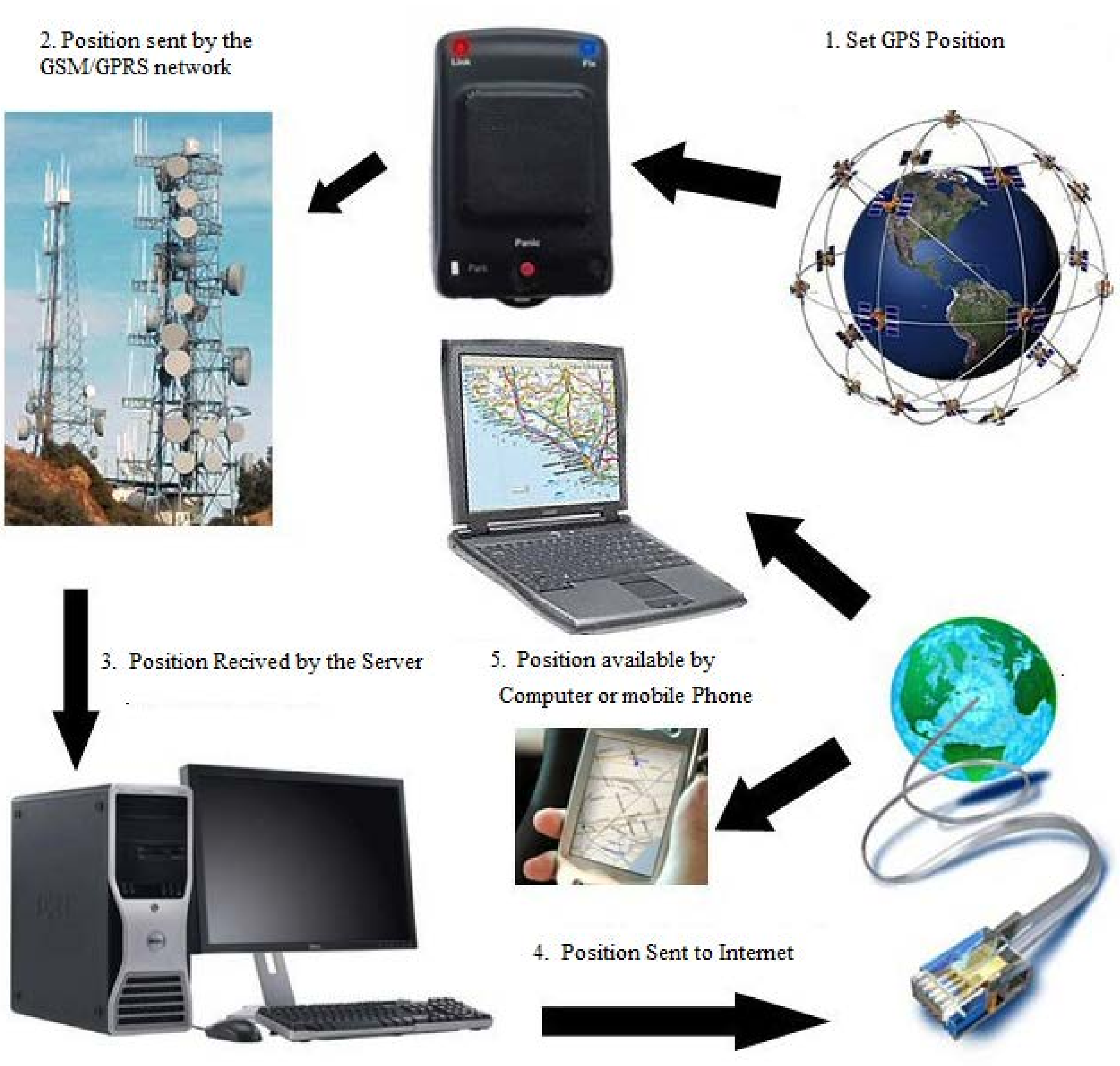

Figure 1: Global Connectivity with APRS-GSM-GPRS

1.2. Direct Sequence Spread Spectrum System (DS/SS) Connectivity

The studied FM system is a DS-SS Signal Band Transmitter Base multiplied by a PN Sequence, whereupon the Signal is expanded. Then the Signal is expanded it is Modulated and Transmitted. The most widely used Modulation Scheme is the BPSK of Figure 2 (Binary Phase Shift Keying) [2].

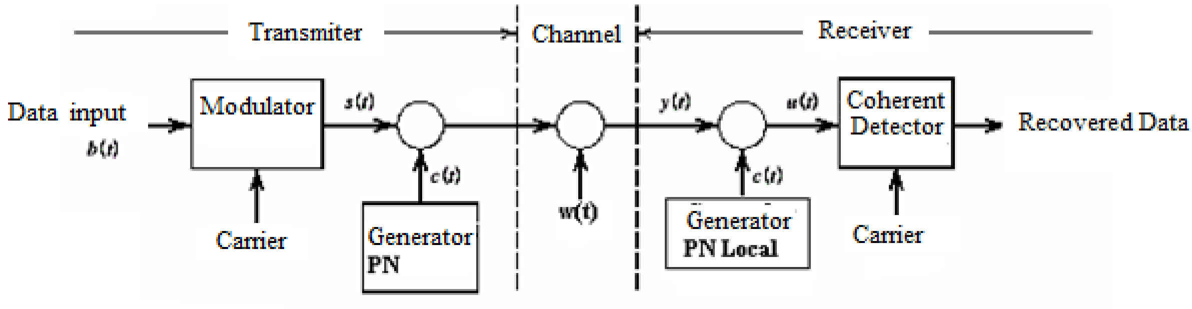

Figure 2: Option for Communication Codified by (DS-SS)

The equation that represents this DS-SS signal is:

$$S_{ss} = \sqrt{\frac{2E_s}{T_s}}\, m(t)\, p(t) \cos(2\pi f_c t + \theta) \quad (1)$$

where:

m(t) → is the Sequence of Data to transmit RFID or GPS

p(t) → Pseudo Noise sSequence is

fc → is the Frequency of the Carrier

θ → is the Angle of the Phase of the Carrier when t = 0

TS → is the Time duration of each Symbol of m (t) data

In this type of modulation Digital Information Signal is modulated by a Pseudo Random Sequence (PN), with a speed much greater than the Information Signal and then transmitted using any type of Digital Modulation as shown in the following figure 3:

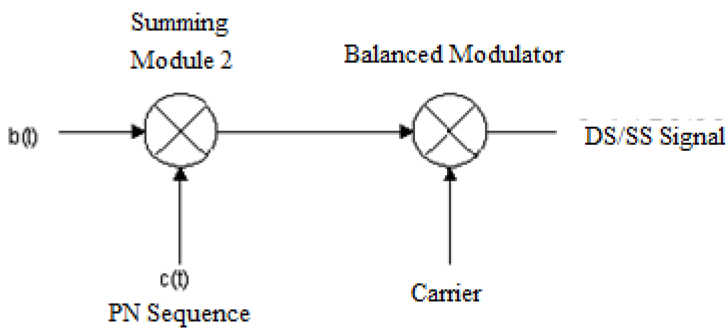

Figure 3: Encoding Process

You can see an example for a Message b (t) given in Figure 4

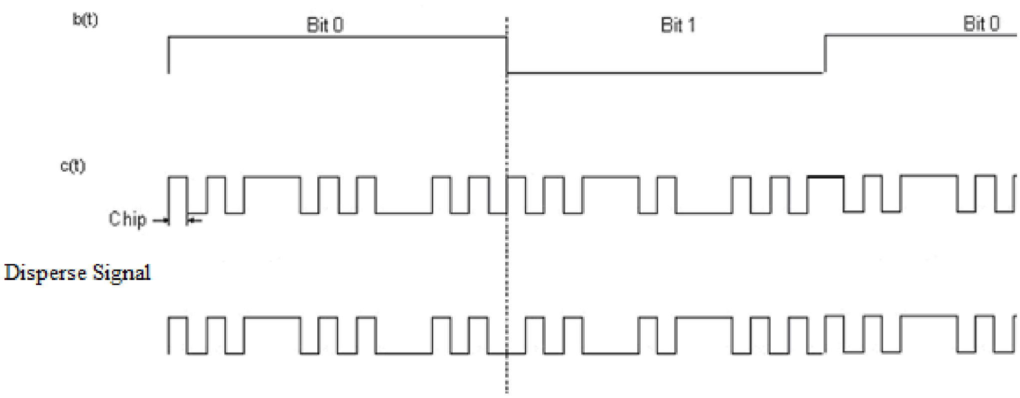

Figure 4: Obtaining a signal encoded in our Traceability System

From equations 1-5 is the DS/SS Signal, in which (before modulation) you canuse the following expression:

$$\mathbf{r_n = \varepsilon b(t) c_n + w_m} \qquad \mathbf{n} = 0,1,\ldots,\mathbf{N} - 1 \quad (2)$$

Where: e is the Energy per Bit of Signal, b (t) represents the Information Signal and is a Polar Signal {±1}

{cn} is a Polar PN Sequence with values {±1} equi-probable, and period N, i.e. that ci+N = ci; the PN Signal can be represented by:

$$c(t) = \sum_{n=-\infty}^{\infty} c_n p_{T_c}(t - kT_c) \quad (3)$$

Where:

PTc(t) is a Rectangular Pulse of unit magnitude and duration Tc; every bit of information duration T will be encoded with N chips duration Tc = T/N, the increase of the reason for the Signal Sampling will be then n. finally Wm represents white noise (AWGN) additive Gaussian of mean zero and Standard Deviation.

After Multiplying the Message by the PN Sequence, the next step is in the Modulation of the Signal using Conventional Digital Modulation PSK.

The Demodulation of the Signal is carried out on the Receiver by Means of a Correlation; This is to multiply the Signal by a Twin of the PN Sequence

$$\mathbf{y} = \sum_{\mathbf{n}=0}^{\mathbf{N}-1} \left(\varepsilon \mathbf{b}(\mathbf{t})\mathbf{c}_{\mathbf{n}} + \mathbf{w}_{\mathbf{m}}\right)\mathbf{c}_{\mathbf{n}} \quad (4)$$

If it is assumed that there is no Correlation (or that is very low) Signal c (t) and the Noise, then the second term vanishes, leaving that and (t) is equal to the Signal b (t) original delayed an amount that depends on the Path of Transmission [3].

$$\mathbf{y} = \mathbf{b}(\mathbf{t}-\tau)\mathbf{c}^2(\mathbf{t}-\tau) = \mathbf{b}(\mathbf{t}-\tau) \quad (5)$$

1.3. The APRS in the Traceability System Receiver

To rescue Signal b (t) you can use either of the following two schedules:

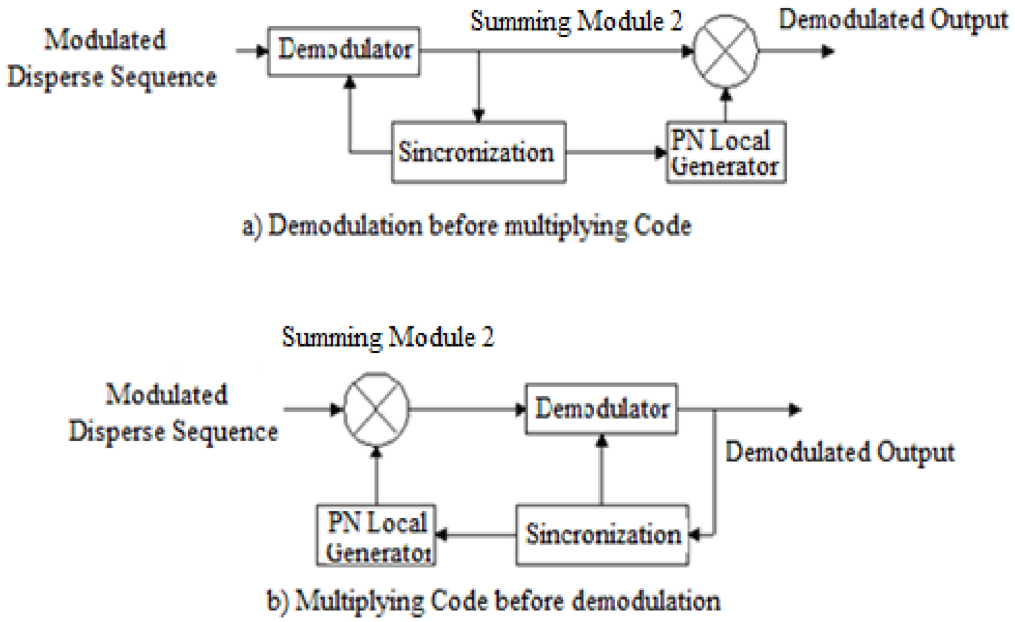

Figure 5: Modulation Process [4].

1.4. Diagrams in blocks of the Transmitter

The System Integration of RFID Mobile with GPS in a Gate for a Traceability System works with a GIS Geographical Images, and to increase the amount of tasks and applications that can be carried out, develops a System Client -Server to allows the Processing Images on other Remote Computers [5]. APRS in our Device Spectrum Space carrying a 13.560 Mhz Modulated Frequency.

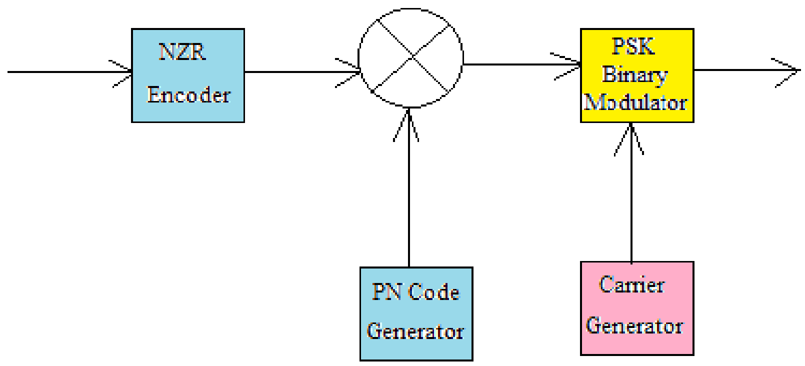

Figure 6: Encoded and Mixed

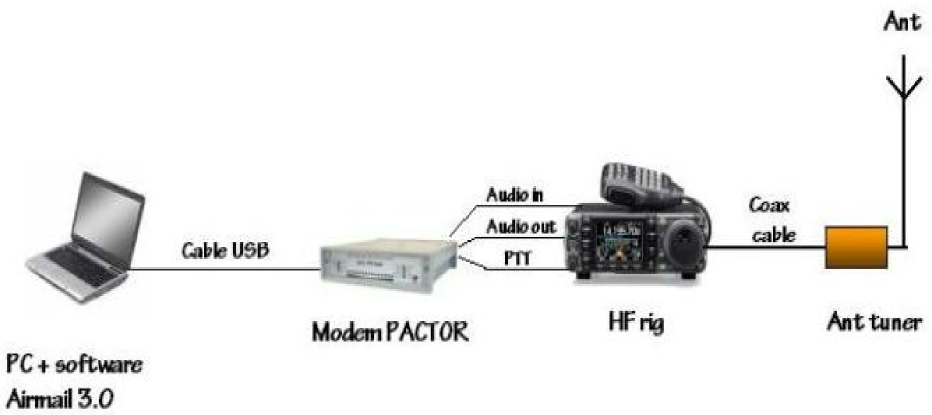

Figure 7: Radio Transceiver for APRS

2. GPS Mathematical aspects

It is defined as the System of Global Positioning of Objects on the Earth through Triangulation from Multiple Geostationary Satellites from a Network of 24 for that purpose [6] and Telemetry.

The basis of GPS represented between 7-10 equations, is in determining the location of the mobile with respect to the Satellite known $\overline{R_m}$ trajectory and the law of the movement, using the equations of dynamics of the Satellite $\overline{R_s}$, the Position will be given for the difference $\overline{R} = \overline{R_s} - \overline{R_m}$ (6)

To determine $\overline{R_m}$, the Satellite continuously transmits two Signals in the L-Band modulated with a Code, for the determination of the Distance, and a Navigation Message. If we know the distance to a Single Satellite, the locus where the phone would be located would be a Sphere; If we know the distance to two Satellites, It would be a Circle, and if there were three known distances, the locus would be one or two points, one of which is rejected by estimates.

As the Receiver Clock is not synchronized to the Satellite Clock, each distance measurement has an error, by what this distance it is known with the name of "Pseudodistance".

PSeudo distance (tr- ti) = distance + c (clock error) (7)

If the variation in Distance is measured by the Receiver, we can also calculate the Speed.

The Position of the Mobile will be given by: $R_a(i) = \sqrt{\left[(X_i - X_a)^2 + (Y_i - Y_a)^2 + (Z_i - Z_a)^2\right]} + c.\Delta t_a$ (8)

Where:

c = Speed of Light

Δt_a = polarization of the Clock of the Ship, Vehicle or Land Person.

i = 1,2,3,4,

2.1. RFID Technology

The RFID (Radio Frequency Identification) is a Radio-Frequency Identification Technology. It's a Small Circuit, with an Antenna, that upon receiving Power via Radio from a foreign issuer responds with a Signal indicating their Status and Position [7].

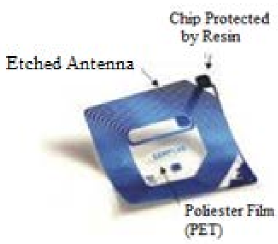

Figure 8: RFID Tag

2.3. A Functional Point of View, RFID Technology

It is based on:

• Tags: also known as Smart Tags. These Tags are being used in tasks of great importance in the area of Identifying Objects, and consist in a Microprocessor and a small Antenna. Smart Tags are often considered as a few bars of new generation, but against the Latter Codes have three great advantages: they can store much more information, you can write about them multiple times and do not need any physical or visual contact point to be able to read them.

• Readers: are the devices that communicate with Smart Tags. They consist of an Antenna and a Power Control Unit. An Electromagnetic Field is generated around the Antenna and Smart Tags are enabled.

The Device that allows the Electronic Identification is called Transponder, which owes its origin to the English words "Transmitter" and "Respond".Technology most used in your application is Passive (no battery) but there are also those of Active technologies. The Transponder operates through the Induction of Radio Waves.

3. Geographic Information System "GIS"

It is integrating Cartography, Remote Sensing Satellite, Storage and Digital Processing, Geography information for automation in Land uses, Society Urban Planning, Ecology, Disasters, Planning and Development [8].

Possible requirements for the establishment of a Geographic Information System GIS: Collection and Data entry, Storage, Data analysis, Presentation of information, and Human Interface.

Figure 9: Geographic Information System Components

4. Automatic Position Information System (APRS).

The APRS System was developed with the idea of attending Radio Amateur Track and Monitor Positions in a Digital Data Format [9].

Some about APRS:

* The Protocol prior to the current "APRs" was called APLS and was introduced in 1991 and Bob Bruninga "Is the Father of APRS"

* The APRS System basically consists of a Large System of Network or Wireless (RF) Circuit in the World.

* This Network consists of Nodes every 20-30 miles that make a Relay or Repetition of the Signal Emitted by a Station that Reports and use Digital Repeater or Digipeaters.

* APRS are used in Space to Track the Position of Satellites and GPS (Data) and GPS Information GPS Receivers Aboard.

* Is also used to Monitor the Telemetry and values of Stations Weather by the National Weather Service (NWS)

APRS has the ability to quickly send Data and values of Telemetry Research Centers without the need for the use of the Internet.

The APRS is used daily to assist in Episodes of Search and Rescue for their Tracking Ability.

An initial intention to APRS was to use its messaging via RF Capacity, and this Official Capacity even if does not exist or is damaged the Internet.

APRS can be used to Transmit Information of Position, Status, Address, Speed, Height and Atmospheric Information WX quickly and accurately using a Network or Circuit of Packet.

The APRS Automatic Packet/Position Reporting System, or System Automatic Information of Position, is a Technology that combines the use of Digital Maps for Positioning in these Stations and Objects, using an Open and Transparent System based on Radio Packages (AX.25) Mode.

5. Traceability with RFID

Traceability referred it is about the Process of objective Location of the Object with its Identification, Size, Quantity and Geo Reference Specifications.

5.1. Diagrams and Formulation of Communication via Radio Frequency

For Transmissions of RFID and GPS Rasters, we can use the Stereo Frequency Division Multipexes to FM (Frequency Modulation) Radio for the Transmission of Audio Signals from Left Channel and the Right Channel of the Transmitter.

$s_L[t]$ left and right (GPS) $s_R[t]$, first become into Digital Signals $s_L[n]$ and $s_R[n]$, by means of individual A/D Converters. In practice, High- Frequency Components have much Higher Amplitudes. However, the Components of Small Amplitudes, produce a Frequency Deviation correspondingly lower. And therefore the resulting FM Signal does not use bandwidth allocated for its Transmission, considerably reducing the Ratio of Signal to Noise at the High Frequency end.

Output SNR on the FM Receiver is increased Emphasis on Higher Frequencies $s_L[n]$ and $s_R[n]$, through Digital Filters of Preemphasis.

The sum of the Signal Input Premphasixed of Discrete Time Left Channel $x_L[n]$ and the Signal Input Premphasixed of Discrete Time in the Right Channel $s_R[n]$, is transmitted in your Baseband for Mono Reception. Also the Difference Signal $x_L[n] - x_R[n]$ (9), is transmitted in the Modulation of DSB-SC (Double Side Band Suppressed Carrier) using a 38 kHZ Subcarrier. The Signal transmitted multiplex and [n],includes the Sum Signal, the Signal Difference DSB-SC Modulator and a Carrier Pilot 19 kHZ. Seen in Figure 10.

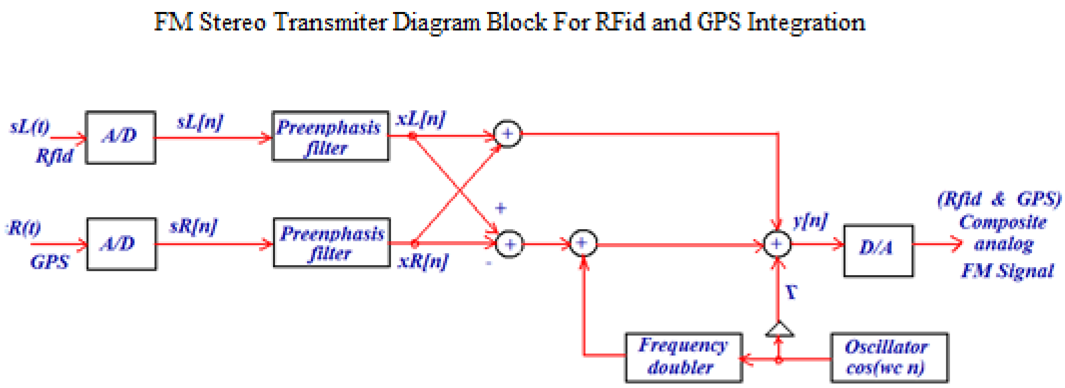

Figure 10: Blocks of the transmission model for RFID and GPS in FM

That is why we present our Design for a possible System of Communication Modulated by Frequency (FM), where our Signal and [n] container of the Plots of the Message of the RFID and GPS, modulate the RF Carrier, to enable Wireless Transmission.

Like this: $y[n] = (x_L[n] + x_R[n]) + (x_L[n] - x_R[n])\cos(2\omega_c n) + \Gamma\cos(\omega_c n)$.(10)

Where

$\omega_c = 2\pi F_c / F_T$ (11) Fc = 19 kHZ and F_T is the Sampling Rate, which is typically 32 kHz (11).

6. Result and Discussion

In Figure 11 we can see the Spectrum of the Signal as Composed by the Carrier Power and Modular RFID and that of the GPS, is designated as a Composite Signal Band base y[n].

The Composite Signal y[n], modulates in frequency to the Main Carrier to generate the Signal to be transmitted.

The value of the Constant Gain Γ for the Pilot Signal is chosen so that the Pilot is seated in a 10% of the Peak Frequency Deviation.

The Original Signal with the Distribution of Power is restored in the Output of the Receiver through a Network of Packaging [10].

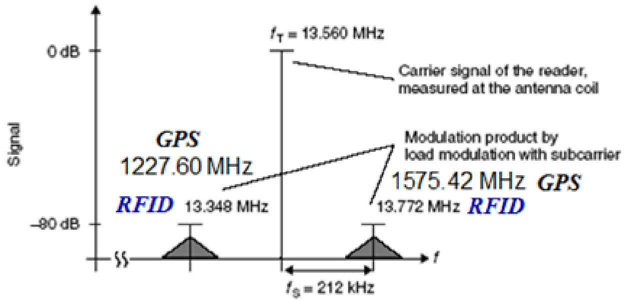

Figure 11: Spectra of the RF carrier of the RFID and GPS

7. Conclusions

In this paper; We Have been presented the Design for a Communication System through Electromagnetic Waves as a Means of Transportation, The System allows us to choose the best way for the Transmission and Reception of the Frames of Messages produced by RFID System allowing the Objects Traceability, and Its Georeferencing, through the Satellite Data Performed and Served by the GPS Global Positioning System.

The development in a Two Communication Channels in a FM Model enabled us to Innovates in the Selection for our best State of Art Innovation for Society Applications, using Algorithms and Analysis of Circuits, and indicating the Recommended Development Strategies for Construction to get the Proposal about a More Efficient University Project.

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