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Address:-Ashok Yakkaldevi 258/34, Raviwar Peth, Solapur- 413 005 Maharashtra, India
Cell : 9595 359 435, Ph No: 02172372010 Email: ayisrj@yahoo.in Website: www.isrj.net

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ORIGINAL ARTICLE

VISSIM-A NOVEL SIMULATION APPROACH FOR MODELLING OF COMMUNICATION SYSTEMS

M.L.S.N. SWARAJYA LAKSHMI AND NIRANJAN PRASAD

K. L. University, Vijayawada; DLRL, Hyderabad .

Abstract:

A typical communication link includes, at a minimum, three key elements: a transmitter, a communication medium (or channel), and a receiver. The ability to simulate all three of these elements is required in order to successfully model any end-to-end communication system. In order to achieve this target we have used simulation software "VisSim" or Visual Simulator that allows us to use a graphical approach to simulation and modeling.. The visual simulator allows us to model end-to-end communication systems at the signal or physical level.. In this paper we explored the advantages of VisSim and simulation of variety of models including analog, digital and mixed mode designs, with including their simulating behavior using the VisSim/Comm software and graphical programming.

KEY WORDS-

VisSim, communication systems, modeling, simulation, real-time.

INTRODUCTION:

A communication system is a collection of individual communication networks, transmission Systems, relay stations, tributary stations, and data terminal equipment (DTE) usually capable of interconnection and interoperation to form an integrated whole.

The components of a communication system serve a common purpose, are technically compatible, use common procedures, respond to controls, and operate in unison. As such any communication system consists of subsystems which work together to achieve a common link, through achieving its own functionality.

The transmitter and receiver elements can in turn be further subdivided into sub-systems. These include a data source (analog or digital), an optional data encoder, a modulator, a demodulator, an optional data decoder, and a signal sink. To understand the process of such a communication we need to visualize or simulate such a link, so as to have a better understanding of the process involved. With graphical programming, the diagram is the source code, depicted as an arrangement of nodes connected by wires. Each piece of data flows through the wires, to be consumed by nodes that transform the data mathematically or perform some action such as I/O(1).

The concept of a data flow diagram (which, unlike a flowchart, shows the motion of data rather than the motion of logic) is nothing new. In fact, even the idea of letting a data flow diagram be the sole input to a compiler or interpreter has been put into practice for years. A number of graphical programming tools are available today, each tailored to a particular industry.

The tool in use, "VisSim" , has a special communication module that allows us to create accurate simulation environment of the communication system involved. It is a software program for modeling end-to-end communication systems at the signal or physical level. Execution is determined by the structure of a

graphical block diagram on which the programmer connects different function-nodes by drawing wires. These wires propagate signals and any subsystem executes as soon as all its input data become available. Since this might be the case for multiple subsystems simultaneously

VISSIM:

VisSim is one of the fastest, most intuitive simulation software package around and an indispensable tool for anyone who needs to model dynamic processes and systems. VisSim can shorten the design stage of any project, reduce costs, provide dependable outcomes for virtual prototypes and provide more results for less effort.

VisSim is an excellent software program for the modeling and simulation of complex dynamic systems. It combines an intuitive drag & drop block diagram interface with a powerful simulation engine. The visual block diagram interface offers a simple method for constructing, modifying and maintaining complex system models. The simulation engine provides fast and accurate solutions for, linear, nonlinear, continuous time, discrete time, time varying and hybrid system designs. With VisSim, users can quickly develop software or "virtual" prototypes of systems or processes to demonstrate their behavior prior to building physical prototypes.

IN VIEWING THE PURPOSE OF EASE OF MODELING VISSIM HAS FOLLOWING ADVANTAGES:

VisSim is a block diagram language for creating complex nonlinear dynamic systems. To create a model, simply drag blocks in the workspace and connect them with wires. Then click the Go button to initiate your simulation. The response is instantaneous. You can choose to display your response in 2D or 3D plots, gauges, bar charts, meters, digital readouts, and even 3D animated scenes. All are driven in real time using the VisSim engine.

VisSim's highly tuned math engine executes your diagram directly with no compilation delay. In addition to accelerating development with rapid turnaround for changes, VisSim's fast execution speeds perfect for model based operator training, off-line controller tuning, and hardware-in-the-loop testing. Its efficient C code generator makes it an ideal platform for model-based embedded system development.

By combining the simplicity and clarity of a block diagram interface with a high-performance mathematical engine, VisSim provides fast and accurate solutions for linear, nonlinear, continuous time, discrete time, SISO, MIMO, multi-rate, and hybrid systems. With VisSim's wide selection of block operations and expression handling, complex systems can be quickly entered into VisSim.

VisSim's tightly integrated development platform makes it easy to pass freely among the stages of model construction, simulation, optimization, and validation. This means you can create virtual prototypes on your desktop and make sure they're working properly before committing to the design. And because VisSim eliminates traditional programming your learning time is minimal.

VisSim has libraries of preconstructed components giving you access to high level models of subsystems like HVAC units, AC and DC electric motors, hydraulic components, gas turbines, human respiration and blood flow, 6-DOF airframe dynamics, counters, timers, logic, and much more. Just right click to get a dialog box, configure to your system parameters, and connect the wires and go.

For specialized engineering problems, VisSim offers a comprehensive set of companion products for frequency domain analysis, C code generation, communications system modeling, DSP and embedded system design, neural networks, OPC, CAN, and real-time analog and digital I/O. These add-on modules are listed in the Products sidebar

With over 100 thousand users across a broad range of industries and disciplines, VisSim is a excellent software for dynamic simulation and model-based development.

Table 1: Various VisSim Software Tools and their Functions

Product	Functions
Professional Vissim	Model based design, simulation, testing and validation of dynamic systems. A personal version Vissim PE is also available. Vissim PE limits diagram size to 100 blocks.
Vissim/comm. Suite	Simulates end-end communication systems at the signal level using 200+ communications, signal processing and RF blocks Includes professional Vissim and Vissim/comm. block set. A personal version Vissim/comm. suite PE is also available. Vissim/comm. PE limits diagram size to 100 blocks and limits the communication block set. Vissim /comm. Suite add-on modules are available for real time data acquisition (Red rapids digital tuner card); modeling PCCC turbo codes, includes UMTS specification; and for support of Bluetooth 802.11a/b/g Wifi and ultra wideband wireless designs.
Vissim/embedded controls	Rapidly prototypes and creates embedded controls for DSPs, DSCs, and MSP430 microcontrollers.A personal version, Vissim/embedded Controls Developer PE, is also available & it limits diagram size to 100 blocks.

VISSIM/COMM:

Based on the core VisSim engine, VisSim/Comm is used for the modeling and simulating end-to-end communication systems at the signal or physical level. With a full complement of communication blocks and a powerful, time-domain simulation engine, VisSim/Comm provides fast and accurate solutions for analog, digital, and mixed-mode communication system designs. The communication block set includes RF, UWB, Bluetooth, 802.x, Turbo Codes, Costas loop, PLL, VCO, BPSK, QPSK, DQPSK, QAM, BER, Eye Diagram, Viterbi, Reed-Solomon and much more. VisSim/Comm was rebadged as "Commsim" by Electronic Workbench and has been used by them for extensive applications.

VisSim/Comm supports a wide range of customizable filters, including FIR, IIR, gaussian, raised cosine and root raised cosine filters. Additional blocks, such as the complex FFT block, make it easy to view gain and phase responses of any filter.

Furthermore, for designs that require adaptive filters, fractionally-spaced LMS equalizer blocks are included. VisSim/Comm highly interactive interface makes it easy to perform 'what if' simulations and carry out performance trade-offs. For example, in analog modulation we can keep amplitude modulation and frequency modulation side by side and evaluate their envelopes shapes, simultaneously.

Using VisSim/Comm, you can freely move among the stages of model construction, simulation, optimization, and validation. This tightly integrated development platform allows you to simulate and view

signal waveforms at any stage of the communication system chain. And all modeling and simulation tasks can be completed without writing a line of code. In short, VisSim/Comm makes it easy to build, modify and maintain even the most complex system models. Many manufacturers of cellular and PCS consumer electronics, has been using VisSim/Comm for years in their research and development efforts(3).

MODELS IN VISSIM/COMM:

Few examples:

Transmitter and Receiver models:

Communication system design can be divided into two categories transmitter design and receiver design. VisSim/ Comm lets us build build both transmitter and receiver models, from a first principles perspective, by simply selecting and connecting predefined blocks. We simulate a variety of models including analog, digital and mixed mode designs, and quickly simulate their behavior. The VisSim/Comm block set provides a variety of modulators and demodulators, including standard analog, PSK, QAM and differential formats..

Channel Models:

VisSim/Comm includes a variety of predefined channel models supporting both fixed and mobile services scenarios. Included are fading, multipath, band limited, and Gaussian noise models. Further all VisSim/Comm blocks, can modify model parameters to suit their specific needs in designing of Filters and Equalizers(4).

Application areas of VisSim:

·Aerospace and defense
·Communications
·Electronics
·HVAC
·Control engineering
·Medical devices
·Power and gas
·Transportation

SOME OF THE SIMULATIONS USING VISSIM:

Combination of AM and FM:

The major advantage that we can have with VisSim is that we can plot the Input Signal, The AM Modulated Signal and the FM Modulated signal simultaneously which helps us in comparing the two outputs with a single source

Here the basic components that are involved:

Input Signal (which is a combination of many sine waves)
AM Modulator (which modulates the input signal w.r.t. Amplitude)
FM Modulator (which modulates the input signal w.r.t. Frequency)
Complex to Real (converts the complex quantity into real & imaginary part)

The outputs that we achieve here are:

1. AM Modulated Signal and Envelope
2. FM Modulated Signal

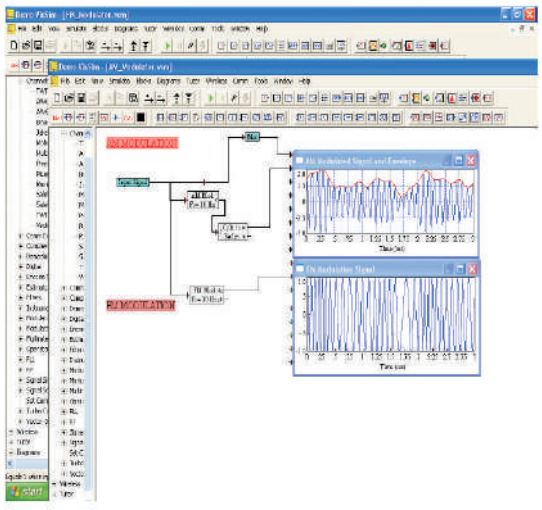

Fig 1: AM VS FM.

MULTIPLEXER:

In electronics, a multiplexer or mux (occasionally the term muldex is also found, for a combination multiplexer-demultiplexer) is a device that performs multiplexing; it selects one of many analog or digital input signals and outputs that into a single line. An electronic multiplexer makes it possible for several signals to share one expensive device or other resource, for example one A/D converter or one communication line, instead of having one device per input signal.

In electronics, a demultiplexer (or demux) is a device taking a single input signal and selecting one of many data-output-lines, which is connected to the single input. A multiplexer is often used with a complementary demultiplexer on the receiving end. An electronic multiplexer can be considered as a multiple-input, single-output switch, and a demultiplexer as a single-input, multiple-output switch.

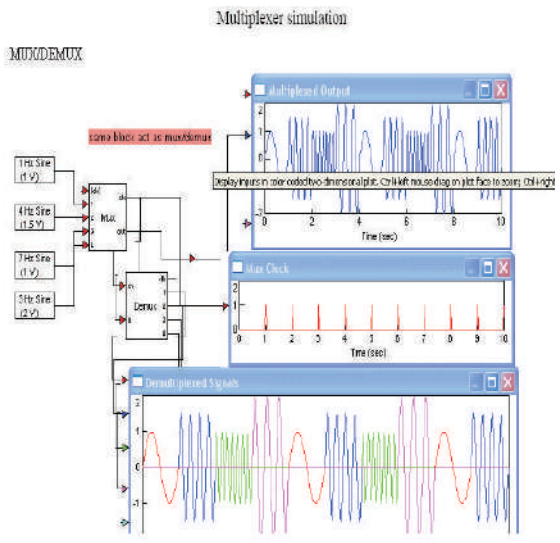

Fig 2: Multiplexer

An equalization(EQ) filter, or an equalizeris a filter, usually adjustable,&mainly meant toCompensatefor theunequafrequency,responseof someothersignalprocessingcircuitorSystemAn EQ filter typically allows the userto adjustone or more parameterthat determinetheoverallshapeof the filter's transfer function. It is generally used to improve the fidelity of sound,toemphasizecertain instrumentst,o removeundesiredhoises(2).

Equalizersmaybedesignedwith Peakingfilters, shelvingfilters, bandpassfilters, plop filters or high-passandlow-passfilters. Fig.3Shownbelowis theblockdiagramof a5 tapadaptivefilter thattakesin input as well as error toadaptivelyequalizethe channel.Furtherchannelequalizationof a QAM link simulationusingVisSimhasshownin Fig4..

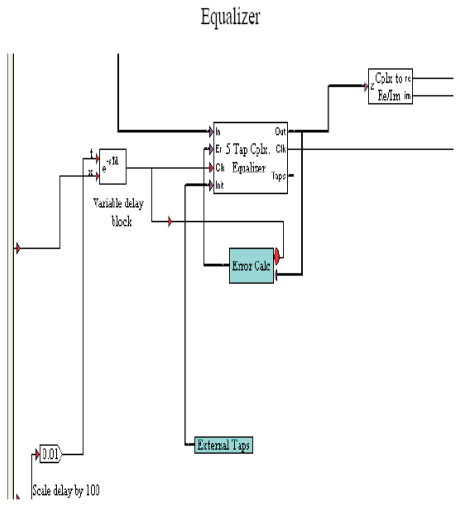

Fig 3:Block Diagram of a 5 Tap Adaptive Filter

Fig 4: Channel equalization of a QAM link:

A mobilechannelis oftencharacterizedby multi-pathpropagation.Whatreallyhappensis thatthe presenceof reflectingobjectsandscatterersin thechannelcreatesa constantlychangingenvironmentthat dissipatesthesignalenergy in amplitude,phaseandtime. Theseeffectsresultinmultiple versionsof the same transmitted signal that arrive at the receiving antenna ,displacedwith respectto one another in time