LabVIEW based Virtual Instrument to Acquire Real Time Signals for implementing Advanced Communication Techniques

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Abstract: *Advanced analysis ability of LabVIEW software for simulating various applications of communication systems has become a potential area for research. Real time acquisition is also made possible through the use of its proprietary Data Acquisition unit. This however, adds to the cost of the entire arrangement and makes it more cumbersome. An attempt has been made in this work to develop a virtual instrument to acquire real time signals in LabVIEW, without the need of its Data acquisition unit to implement Time Division Multiplexing and Frequency Division Multiplexing. Two function generators are used to provide the real time input sinusoidal signals and this data is then fed through a dual channel jack connected at the sound port of the computer. LabVIEW acquires the signals appearing at this port through its 'Acquire-sound' block. The results obtained clearly shows Time and Frequency division multiplexing of the real time acquired signals. Other advanced communication techniques can also be implemented in real time using this arrangement.*

Key Words: *Communication technique, LabVIEW, Real time acquisition, Time division multiplexing, Frequency division multiplexing, Virtual Instrument*

1. INTRODUCTION

Simulation of various communication techniques has been implemented through software like MATLAB and LabVIEW. Using LabVIEW, one can develop a real-time function using its compatible hardware called National Instrument's Educational Laboratory Virtual Instrumentation Suite II (NI ELVIS II) that also enables solutions to communication system applications [1]. This includes acquiring, pre-processing, extracting, and analyzing communication functions. In a certain work, Local Interconnect Network (LIN) simulation system based on LabVIEW has been developed using USB-LIN smart card having Freescale's 16-bit Micro Controller Unit [2]. This is however a simulation approach. In a different work control of filter parameter on communication quality is analyzed using LabVIEW [3]. This is again a simulation effort that calculates communication quality of a satellite communication system using pulse shaping filter. Yet another communication system application has been developed using LabVIEW that allows UHF RFID Tag Test Measurement. This work however, requires National Instrument's proprietary LabVIEW-controlled PXI RF hardware, thus making the arrangement expensive [4]. A real time Mobile Data acquisition (DAQ) System for Radio Signals has also been built Using LabVIEW [5]. This Measurement Set Up system using LabVIEW requires NI's DAQPad-MIO-16XE-50 interface and RS-232 for input output.

Commonly used communication procedures include Time-division multiplexing (TDM) and Frequency-division multiplexing (FDM). TDM is one communication system technique where a set of low-bit-rate streams, each with a fixed and pre-defined bit rate is mixed into a single high-speed bit stream that can be transmitted over a single channel. It has many applications, including wire-line telephone systems and some cellular telephone systems. The reason to use TDM is to utilize existing transmission lines for multiple signals, thereby reducing the overall cost of transmission. Similarly, Frequency-division multiplexing (FDM) is a form of signal multiplexing where multiple base-band signals are modulated on different frequency carrier waves and added together to create a composite signal. For example, a Television channel is divided into sub-carrier frequencies for video, color, and audio using FDM. A LabVIEW based virtual instrument has already been made that implements TDM and FDM, but uses simulated sine waves [6]. An attempt has been made in this work to multiplex two real time acquired signals in

LabVIEW, without using any external DAQ unit. Section 2 of the paper presents the material and method used to design and implement TDM and FDM in real time using LabVIEW. Section 3 gives a discussion on the results obtained. The final section concludes and describes the future scope of this work.

2. MATERIAL AND METHODOLOGY

The experimental set up for multiplexing two real time acquired sinusoidal signals in LabVIEW is shown in Fig. 1, followed by block diagram of the arrangement in Fig. 2. The set up requires two function generators, dual channel interfacing jack, probes, computer and LabVIEW software (ver 8.2). Sinusoidal signals of two different frequency and amplitude are obtained using the function generators. These signals are fed to the sound port of the computer through a dual channel jack. The signal is then acquired in LabVIEW as per the flow chart explained. Flow chart for designing a real time acquisition set up for Time division multiplexing is shown in Fig. 3. Snap shot for block diagram of the Virtual instrument (V.I) developed as per the flow chart is shown in Fig. 4.

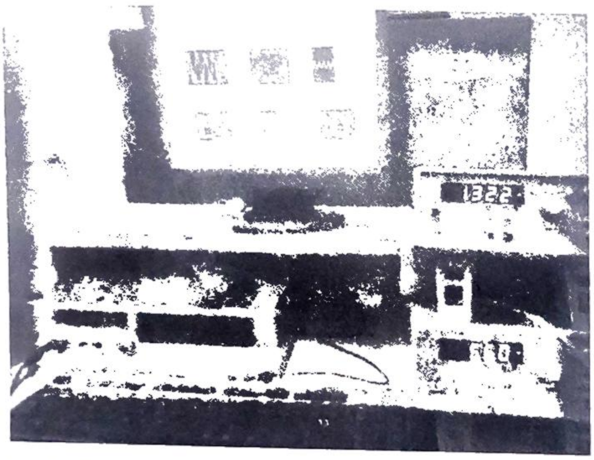

Fig.1. Experimental set up for multiplexing real time acquired sinusoidal signals in LabVIEW

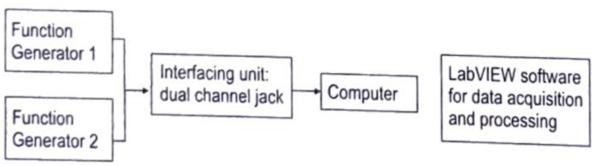

Fig.2. Block Diagram for acquiring two real time signals in LabVIEW

The Virtual instrument includes 'Acquire Sound' block to acquire the real time sinusoidal signals from the function generator. Parameters of this block are set

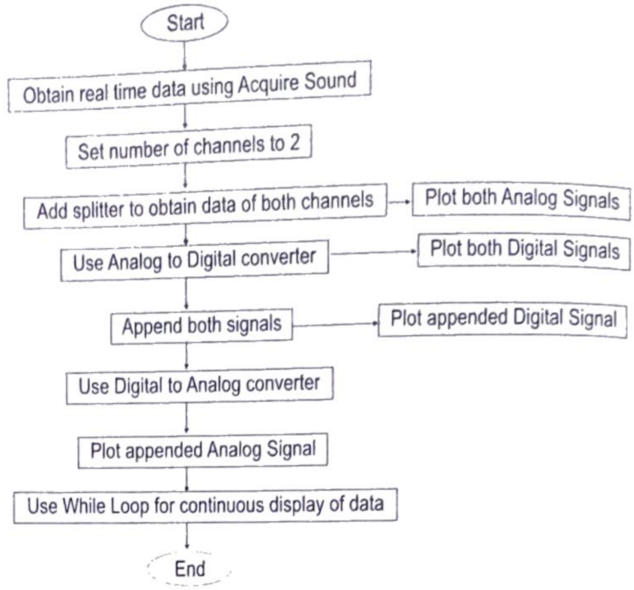

Fig.3. Flow chart for real time acquisition of two signals for Time division multiplexing

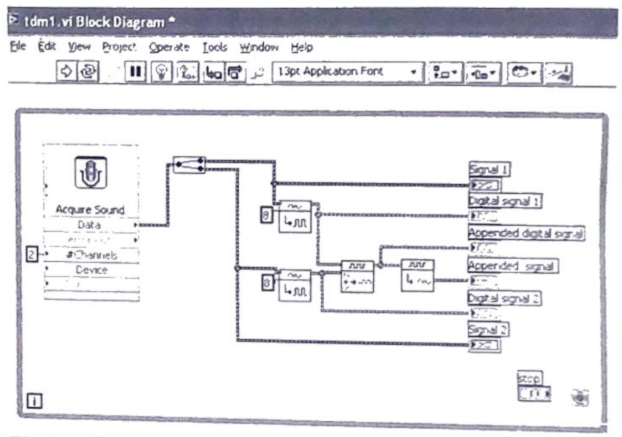

Fig.4. Virtual Instrument for real time acquisition of two signals for Time division multiplexing

as per the requirement. Both the signals acquired are then separated using a splitter and then plotted using 'Waveform Graph' [7] and the result is shown in section 3.

These signals are analog in nature, so for multiplexing them, they are digitized using 'Analog to Digital Converter' block. The digital signal now obtained is plotted using 'Digital Waveform Graph'. TDM technique requires two or more signals or bit streams to be transferred simultaneously as sub-channels in one communication channel. Hence, the digital signals are multiplexed using 'Digital waveform data output (DWDT) Append Digital Samples' block. This block appends all samples from digital waveform 'B' to the end of digital waveform 'A'. The appended digital signals are then plotted. For viewing the multiplexed analog signals, the digitized signal is converted back into analog form using 'Digital to Analog Converter' block and is then plotted.

Flow chart for designing a real time acquisition set up for Frequency division multiplexing is shown in Fig. 5. Snap shot for block diagram of the Virtual instrument developed as per the flow chart is shown in Fig. 6. This Virtual instrument again requires 'Acquire Sound' block to acquire the real time sinusoidal signals from the function generator. Both the acquired signals are then separated using a splitter block and plotted. These real time acquired signals are used as the message signals. For FDM two message signals are superimposed on two different carriers. So, high frequency carrier signals are generated using 'Simulate Signal' block of LabVIEW and are plotted. The message signal is superimposed on the carrier wave using the 'Multiplier' block. Both the superimposed signals are the added using 'Adder' block to obtain FDM. The frequency multiplexed signal is then plotted using 'Waveform Graph'. The results for TDM and FDM obtained can be seen on the 'Front Panel' of the Virtual instrument in LabVIEW, which is explained in the subsequent section.

3. RESULTS AND DISCUSSIONS

The LabVIEW virtual instruments designed in this paper: successfully multiplexes two real time acquired

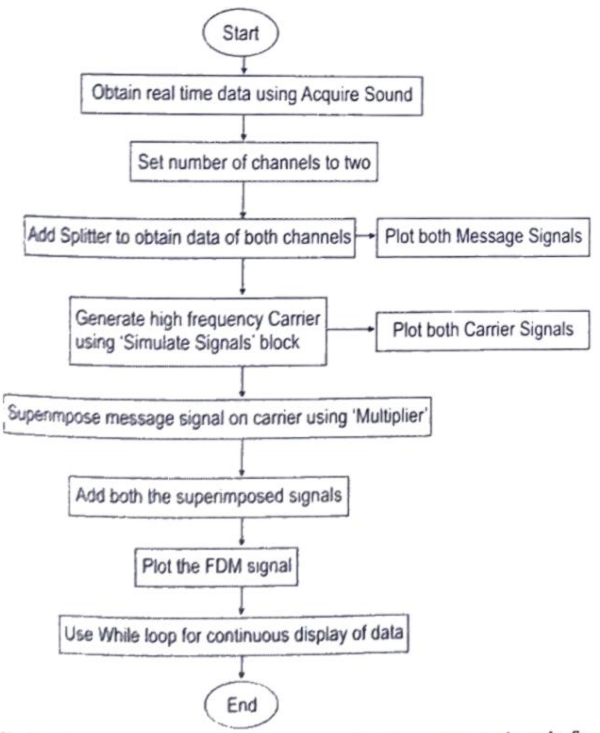

Fig.5. Flow chart for real time acquisition of two signals for Frequency division multiplexing

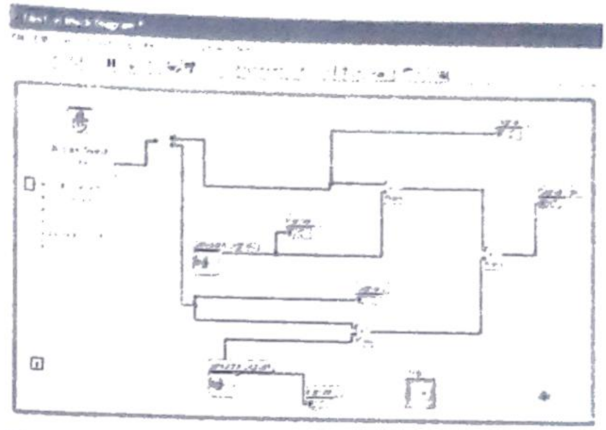

Fig.6. Virtual Instrument for real time acquisition of two signals for Frequency division multiplexing

sinusoidal waveforms in time domain and frequency domain. The result obtained for TDM is shown in Figs. 7 and 8 for different amplitude and frequency setting of real time signals. The snap shot in Figs. 7 and 8 shows analog signal 1 and 2 and their digital plots. Analog appended signal and its digital version can also be clearly seen in these plots.

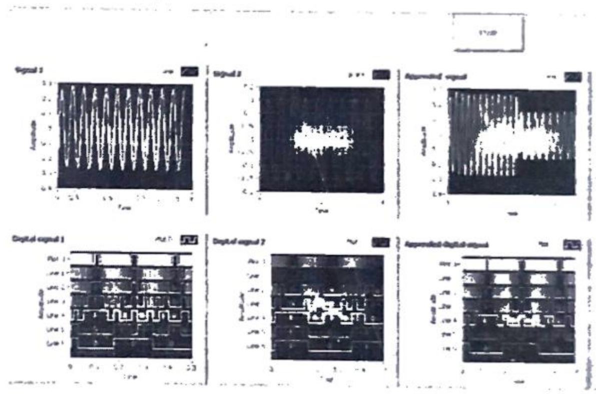

Fig.7. Snap shot of front panel showing real time TDM in LabVIEW

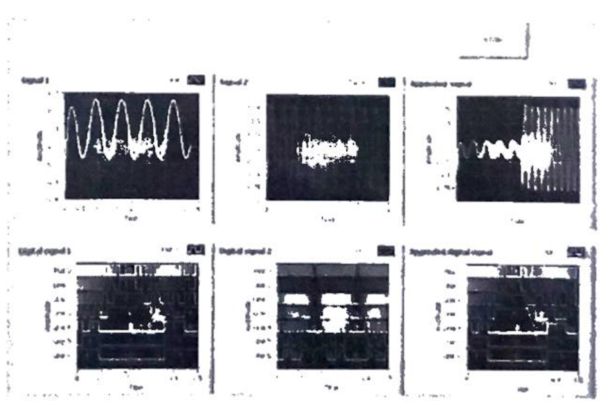

Fig.8. Another snap shot of front panel showing real time TDM in LabVIEW

The result obtained for FDM is shown in Figs. 9 and 10 for different amplitude and frequency settings of real time signals and also for different frequencies of simulated carrier signals. The snap shot in Figs. 9 and 10 shows low frequency message signals 1 and 2 along with the high frequency carrier waves 1 and 2. The FDM signal obtained can also be clearly seen in these plots. Due to use of a dual channel jack at the sound port, only two real time signals could be acquired in FDM and so the carrier used were simulated. The system can further be enhanced to capture multiple channel inputs in real time, by using multiplexers.

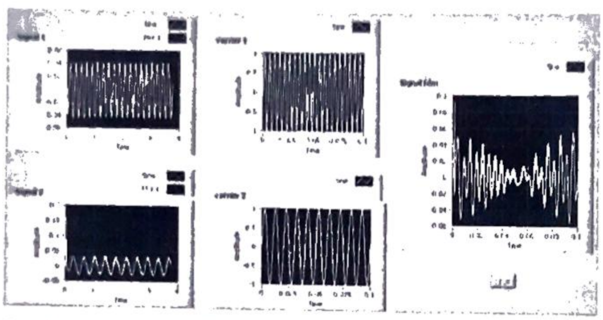

Fig.9. Snap shot of front panel showing real time Frequency division multiplexing in LabVIEW

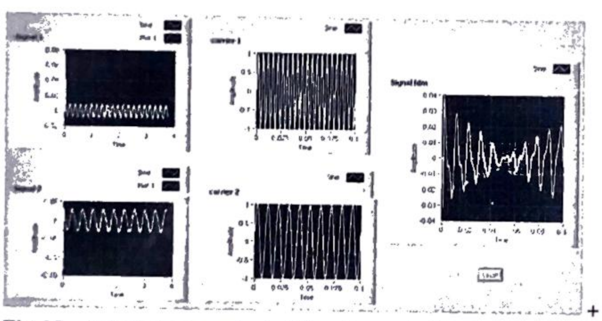

Fig.10. Another snap shot of front panel showing real time Frequency division multiplexing in LabVIEW

4. CONCLUSION

The block diagram developed in LabVIEW is successful in continuously acquiring real time signals and multiplexing them in time and frequency domain. The signals are acquired without need of additional NI hardware, as the inbuilt Sound card of P.C with dual channel jack is utilized for the purpose. The same arrangement can be utilized to implement other advanced communication techniques. Thus, with LabVIEW, one can control different real time applications using the same setup, thus reducing development time and costs.

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