

2 KHz Successive Acoustic Pulse Signal Generation with Different Phases for SODAR System Using PC Sound Card and MATLAB Graphical User Interface

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ABSTRACT – The Paper “2 KHz Successive Acoustic Pulse Signal Generation with different Phases for SODAR system using PC Sound card and MATLAB Graphical User Interface” is extension work for the paper title “2 KHz Mono Pulse Acoustic Signal Generation for SODAR Application using PC Sound card and MATLAB graphical user interface”. In previous paper the work has carried out with generating an Acoustic signal with specified frequency with some span of delay. This acoustic signal has propagated in one direction into the atmosphere. Here in this paper the work has carried out for generating the acoustic signal with some phase difference, which cause the change in the direction of the signal propagation. Here the generated signal has in time delay and for each time delay phase of the signal has changes in between 45, 90, 135 degrees, to obtain three directions in propagation signal as shown in the Fig 1. The SODAR (Sound Detection And Ranging) is an instrument that to measure the wind profile in the lower atmosphere of the earth. The volume measurement of the wind profile by remote sensing device, like SODAR have a great advantage compared to point measurements in a one height. In SODAR, acoustic pulses are sent vertically and at a small angle to the vertical. A thus transmitted sound pulse is scattered by the fluctuations and gradients as well as wind shear. There are five basic parameters that determine how the SODAR sends the beam. These are Transmit Frequency (FT), Transmit Power (PT), Pulse Length (τ), Rise Time ($\beta\tau$) and Time between pulses (T). There are two further parameters, namely “Tilt angle” and “Half beam width”, which describes the beams of the antenna, but cannot be controlled by the software like MATLAB. MATLAB is a high-level language and interactive environment for computations, visualizations and programming. This language tool, and built-in mathematical functions will enable you to explore multiple approaches and reach a solution faster than with spreadsheets or traditional programming languages, such as C or C++ or VC++. Among the five basic parameters mentioned above, Transmit Frequency (FT), Pulse Length (τ) and Time between pulses (T) are controlled by designing the Graphical User Interface (GUI) of MATLAB. GUIs also known as graphical user interfaces or UIs provide point-and-click control of software applications, eliminating the need to learn a language or type commands in order to run the application. Thus using this GUI, user desired values of a SODAR beam can be generated. This paper is divided into four different layers such as user layer, application layer, operating system layer, and Hardware / Physical layer. The user layer gives the input to the application layer by mouse click or inputs through GUI icons. The application layer performs the signal processing such as parameter determination and further communicates with the operating system layer. The operating system layer acts as a bridge between hardware layer and application layer. Finally the Hardware / Physical layer takes care of commands executions, which are given by operating system layer. The advantage with this design of GUI replaces the ancient analog system using for beam generation.

Keywords: Successive -pulse, phase, Acoustic, SODAR, atmosphere, propagation, Sound Card, GUI, Transient, Rise Time, Transmit Power, Pulse length, Tilt, angle, MATLAB.

I. INTRODUCTION

The SODAR (Sound Detection And Ranging) is an instrument that to measure the wind profile in the lower atmosphere of the earth. The volume measurement of the wind profile by remote sensing device, like SODAR have a great advantage compared to point measurements in a one height. In SODAR, acoustic pulses are sent vertically and at a small angle to the vertical. A thus transmitted sound pulse is scattered by the fluctuations and gradients as well as wind shear. There are five basic parameters that determine how the SODAR sends the beam. These are Transmit Frequency (FT), Transmit Power (PT), Pulse Length (τ), Rise Time ($\beta\tau$) and Time between pulses (T). There are two further parameters, namely “Tilt angle” and “Half beam width”, which describes the beams of the antenna, but cannot be controlled by the software like MATLAB.

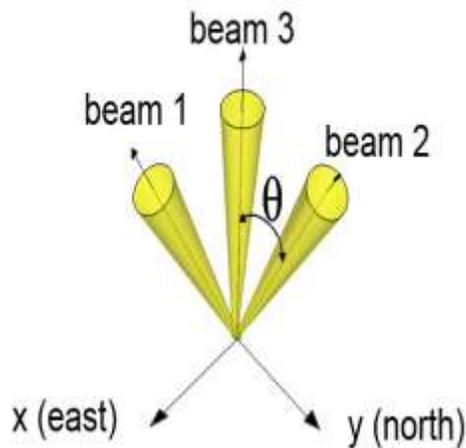


FIG1: ANATOMY OF SODAR SYSTEM SIGNAL DIRECTION.

MATLAB is a high-level language and interactive environment for computations, visualizations and programming. Meanwhile you have a chance to analyze data, develop algorithms and a create models and applications. This language tool, and built-in mathematical functions will enable you to explore multiple approaches and reach a solution faster than with spreadsheets or traditional programming languages, such as C or C++ or VC++. Main Key features of the MATLAB is 1. Mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, numerical integration, and solving ordinary differential equations. 2. Built-in graphics for visualizing data and tools for creating custom plots. 3. Development tools for improving code quality and maintainability and maximizing performance. 4. Tools for building applications with custom graphical interfaces. 5. Functions for integrating MATLAB based algorithms with external applications and languages such as C, Java, .NET, and MicrosoftExcel. 6. Creating Apps with Graphical User Interfaces in MATLAB. In this paper GUI has taken major role into generation of SODAR signal. GUIs also known as graphical user interfaces or UIs provide point-and-click control of software applications, eliminating the need to learn a language or type commands in order to run the application. MATLABapps are self-contained MATLAB programs with GUI front ends that automate a task or calculation. The GUI typically contains controls such as menus, toolbars, buttons, and sliders. Many MATLAB products, such as Curve Fitting Toolbox, Signal Processing Toolbox, and Control System Toolbox, include apps with custom user interfaces. You can also create your own custom apps, including their corresponding UIs, for others to use. GUIDE (GUI development environment) provides tools for designing user interfaces for custom apps. Using the GUIDE Layout Editor, you can graphically design your UI. GUIDE then automatically generates the MATLAB code for constructing the UI, which you can modify to program the behavior of your app. With the help of this MATLAB apps we are going to access the SOUND CARD of the system (PC/ LAPTOPS) to generate the specified user desire sound in frequency and other parameters. A sound card also known as an audio card is an internal computer expansion card that facilitates the input and output of the sound signals to and from a computer under control of computer programs like MATLAB, C language and VC++. Typical uses of sound card include providing the audio component for multimedia application such as music composition, editing video or audio, education and entertainment games, presentation, and video applications like projection. Sound functionality can also be integrated onto the motherboard, using basically the same components as a plug in card. The best plug in card, which use better and more expensive components, can achieve higher quality than integrated sound. The integrated sound system is often still referred as a sound card. The powerful GUI function facilitate the time-height plots in such a way that the plot can be stored, retrieved and processed to eliminate unwanted fixed echo-signals, which are of non-atmospheric origin for the SODAR system. In order to present the data on the client area of a window, the GUI is critical in visual C++ programming language. The present system is divided into layer, and Hardware / physical layer. Fig 1 shows the block diagram of the layer structure of system-based applications. Each layer takes care of the commands received from respective layers. The user layer gives the input to the application layer by mouse click or inputs through GUI icons. The application layer performs the signal processing such as parameter determination and further communicates with the operating system layer. The operating system layer acts as a bridge between hardware layer and application layer. Finally the hardware / physical layer takes care of commands executions, which are given by operating system layer.

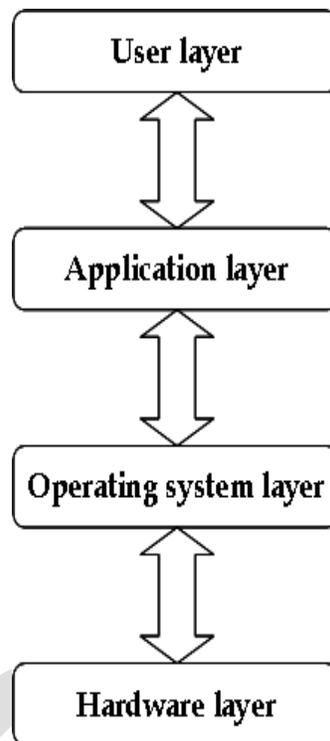


FIG 2: BLOCK DIAGRAM OF LAYER STRUCTURE FOR THE PC-BASED APPLICATION.

II. DESIGN FEATURES

There are five basic parameters that determine how the SODAR sends the beam. These are Transmit Frequency (FT), Transmit Power (PT), Pulse Length (τ), Rise Time ($\beta\tau$) and Time between pulses (T). There are two further parameters, namely “Tilt angle” and “Half beam width”, which describes the beams of the antenna, but cannot be controlled by the software like MATLAB. Apart from this first thing is that we need to access the sound card to generate the sound signal internally by using the software program. Here it is going to describing that how we are going to access the sound card by using MATLAB program. Basically an analog output object associated with the winsound device is created. One are more channels are then added to the analog output object, a0. This will allow the winsound device to run in stereo mode. Before accessing sound card, the output data to a sound card using the “data acquisition” tool box generates the analog output. These data has stored in the HANDEL.MAT file, will be used to generate the further sound signal in wave form and displayed in the axes window.

```
a0 = analogoutout ('winsound', 0);  
addchannel(a0, [1,2]);
```

FIG 3: BASIC SYNTAX OF MATLAB TO ACCESS SOUND CARD

HANDEL.MAT contains two variables: 1.The data that will be output to the sound card and 2. The sample rate are at which the data was originally sampled. The data and sample rate are loaded from the HANDEL.MAT into the MATLAB with function of “load handel”. The analog output objects is configured to use the loaded sample rate. For the loaded data to be output, it must first be queued in the data acquisition engine must consist of a column of data for each channel of the analog output object.

```

Data = [y y];
putdata (a0, data);
    
```

FIG 4: BASIC SYNTAX OF MATLAB TO OUTPUT THE DATA.

Now the analog output object and the data acquisition engine are started with the START command. Starting the output object means that the hardware device and the data acquisition engine are both running. Running does not necessarily mean that the data is being output. For data to be output. A trigger must occur, by default, an immediate trigger occurs as soon as the object is started.

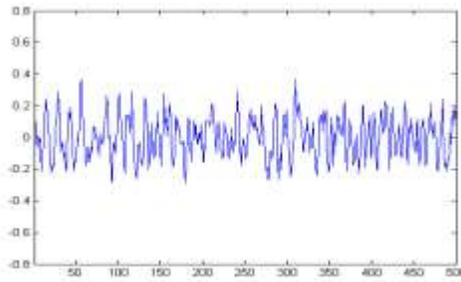


FIG 5: ANALOG OUTPUT IN AXIS WINDOW

A corresponding plot is drawn while the sound plays when total program has executed in the MATLAB workspace. When the data has been output, the analog output object is stopped automatically. The analog output object should be deleted with the “DELETE” command to free memory and other physical resources.

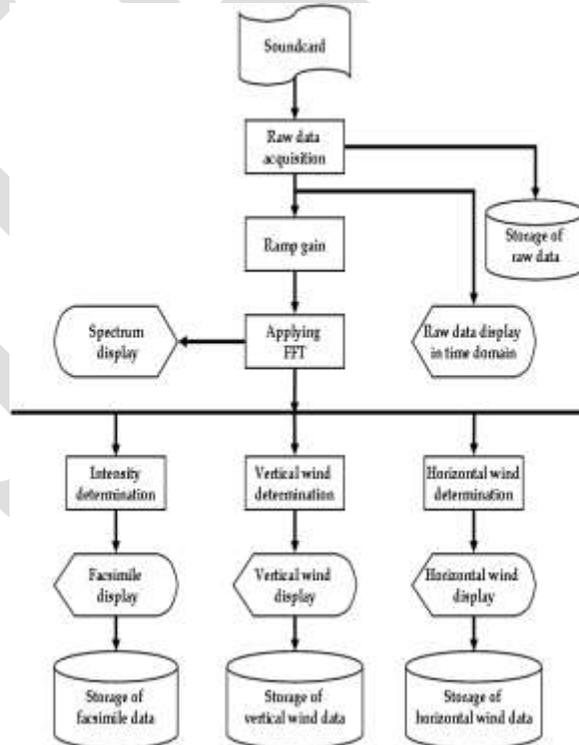


FIG 6: THE STRUCTURAL BLOCK OF SODAR SOFTWARE.

III. GUI SIMULATION RESULTS

Main frame of SODAR GUI will consists five buttons namely 1. SODAR ON: when we select this button on, the basic phenomenon has starts in the background and gives the message if it's ready to select the other parameters. 2. TRANSIENT FREQUENCY: when this button will press immediately it will asks the range of values in Kilo Hertz, which indicates the frequency of the original SODAR signal.



FIG 7: SODAR antenna at Dept. of Systems Design, Andhra University. Sponsored by UGC and ISRO.

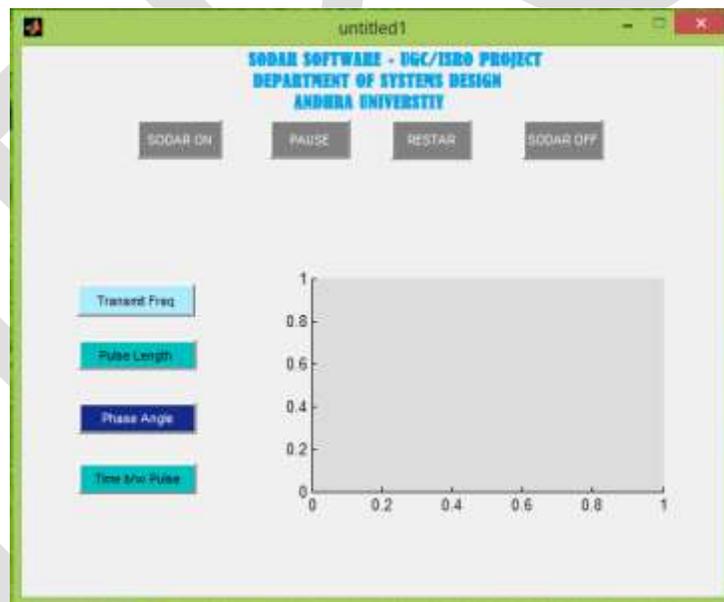


FIG 8: MAIN FRAME OF SODAR GUI IN OFF STATE

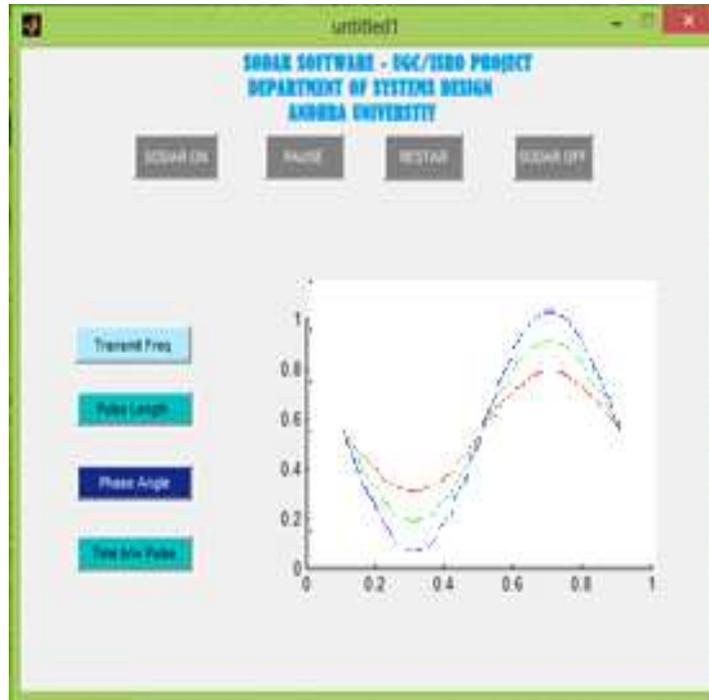


FIG 9: MAIN FRAME OF SODAR GUI IN ON STATE

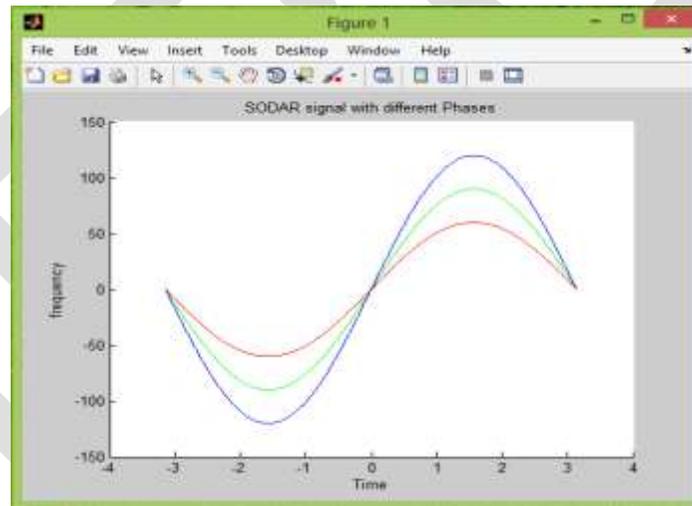


FIG 10: SODAR SIGNAL WITH DIFFERENT PHASES

3. PULSE LENGTH: Which describes the length of the SODAR signal pulse in the time in mille seconds/ seconds. 4. PHASE ANGLE: This parameter is most important in this paper, which is decides the particular tilt angle of the propagation signal. Here basically taken three values in between 45 to 135 degrees lower the degree will tilt the signal left side and higher the degree will tilt towards the right side. So signal with same Frequency with different phase will propagate different sides. This process of propagation will continue until or unless we stop the system. 5.TIME BETWEEN PULSES: This is one of the important factor that plays major role when reception of the SODAR signal is going. Mostly in all SODAR systems we will take it as 2 seconds of duration to get better echo and eliminate the interference between transmitted and reception signal. 6. GRAPH AXIS: Which shows the whether the sound card is generating the sound signal or not. If this graph is pure sine wave then the signal will have better transmission. 7. SODAR RESTART: Sometimes it necessity to restart the total process of the system, so at that time we need not to stop all the hardware and software. This button will simple restart the entire system and rearrange the parameters with previous values. If you want to change the parameters of the system the it need to stop the system and then enter the new values. 8. SODAR OFF: this switch is for off the

total signal generation from the PC SOUND CARD only and also use full for reset/clear the memory of the sound card. In this paper we are only discussing about transmission of the SODAR signal. If we include the reception part in the GUI will have few more buttons and graph axis to display the output signal and its type like time-frequency graph or 'fft' of the reception signal. 9. PAUSE: Its simple button, which pauses the generation of the signal until unless re-click on the same button. After re-click, the system will starts its process with previous values only.

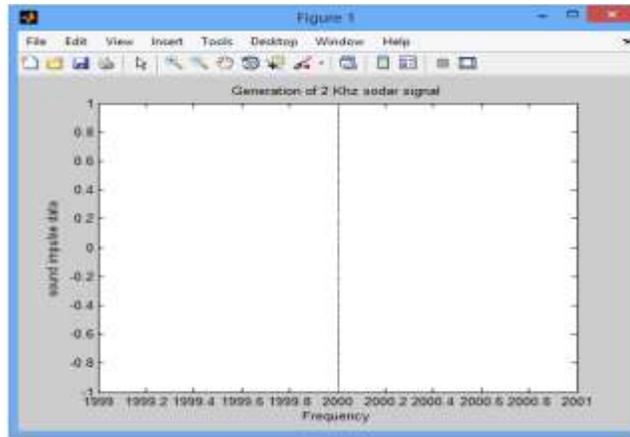


FIG 11: GENERATION OF 2 KHz SIGNAL WITHOUT GUI

Above figure shows the signal generated by sound card with a raw program, in which we do not have the chance to modify the characteristics of the signal.

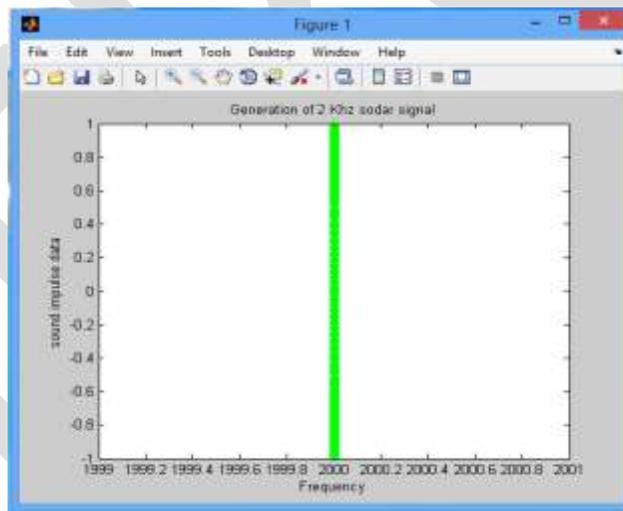


FIG 12: GENERATION OF 2 KHz SIGNAL GUI

Above figure shows the signal generated by sound card with the help of GUI, in which we have the provision to modify the characteristics of the signal. This GUI is programmed in such way if the SOUND card has any problem, which may lead to generate the Noise, will adjust itself and outputs the user desired pure sine wave and displays the signal in the impulse format as shown above figure.

IV. CONCLUSIONS

Defining the parameters for SODAR system to using object- oriented application like MATLAB, will gives tremendous advantages. This object – oriented program are rich in structure, methods and attributes. This paper is divided into four different layers such as user layer, application layer, operating system layer, and Hardware / Physical layer. The user layer gives the input to the application layer

by mouse click or inputs through GUI icons. The application layer performs the signal processing such as parameter determination and further communicates with the operating system layer. The operating system layer acts as a bridge between hardware layer and application layer. Finally the Hardware / Physical layer takes care of commands executions, which are given by operating system layer. Therefore designing of this software will also reduce the cost effect and hardware compellability and can use worldwide with Microsoft platform.

V. ACKNOWLEDGEMENT

The work has been carried out with the financial support by UGC, New Delhi through a major research project entitled "2 KHZ SUCCESSIVE ACOUSTIC PULSE SIGNAL GENERATION WITH DIFFERENT PHASES FOR SODAR SYSTEM USING PC SOUND CARD AND MATLAB GRAPHICAL USER INTERFACE".

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