

Arbitrary Waveform Generator

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Abstract: As engineering students we are aware that there are different generators which produce standard signals (sine, square etc.) or their combinations. But what if we want to produce signals which are arbitrary in real sense? We have almost no techniques in producing waveforms such as ECG or EEG. These are random and cannot be produced by any instruments. It would be very difficult to produce such a waveform. This was the notion which set us to produce such an instrument which produced really an arbitrary signal along with standard ones. It was implemented using DSP processor. A bit of image processing was also used for reading image. But for a more practical approach, we are implementing this using microcontroller.

Keywords: Arbitrary, DSO, MATLAB.

I. INTRODUCTION

The waveform generator can be considered as visual to physical domain converter. In this process waveform to be produced is drawn in Paint or as in microcontroller based on touch-screen. This is the input to our instrument. Then by reading the image and its amplitude sample we can recreate the waveform. This is the working in a nutshell. The advantage of using DSP processor is that it makes the process easier as it has an inbuilt Codec (TLV320AIC23B). But using microcontroller the cost of the instrument can be reduced and it is a more practical approach. The detailed working is given in the proceeding points.

II. DETAILED WORKING

As this project had been implemented using DSP processor and will be implemented using microcontroller we will see their implementation separately.

I. Using DSP processor

In this the first step is to draw the waveform which is to be reproduced is drawn in MS Paint. While drawing in paint we have to take care that the number of pixels in 'width' should be integer multiple of the number of samples you want in one cycle of the waveform that you are going to draw. For example, if you want 48 samples of the waveform you have drawn, the width pixels can be 960. These changes can be made in the attribute option available in paint.

The amplitude samples are found out by the MATLAB program. But we have to be cautious about one thing. We have to store the image in the same folder where the MATLAB program had been stored. This makes it easy for the program to detect the image. Open the MATLAB program and run it. First it will ask for number of samples. Put the desired one following the rule that was given previously that number of pixels in width divided by the number of samples should be integer.

These amplitude samples have to be copied in the CCS program i.e. Code Composer Studio. This is the software used for programming DSP processor. After compiling the program we must download it in the processor. The output can be seen on DSO after connecting the jack to line-out of AIC23 codec.

The block diagram below shows a brief step by step execution of the process :

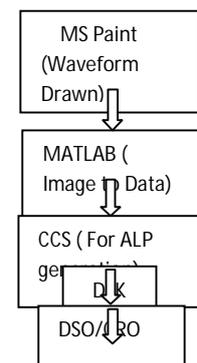


Fig 1 Block diagram of ASG with DSK

Some results which were obtained using DSP processor are shown below:

1)

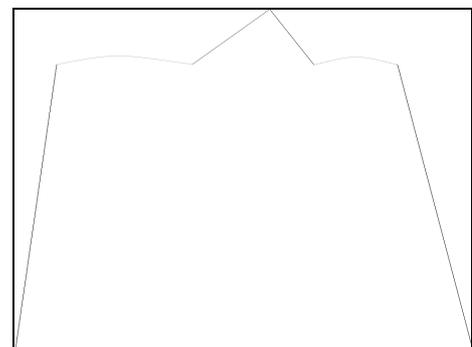


Fig 2 Waveform 1 using DSK

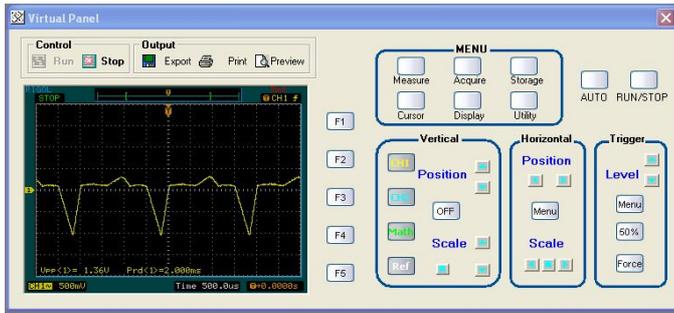


Fig 3 DSO output of the waveform

2)

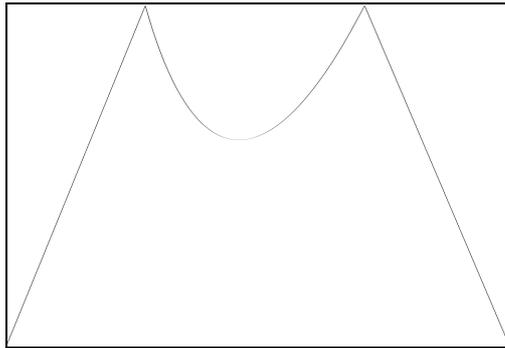


Fig 4 Waveform 2 using DSK

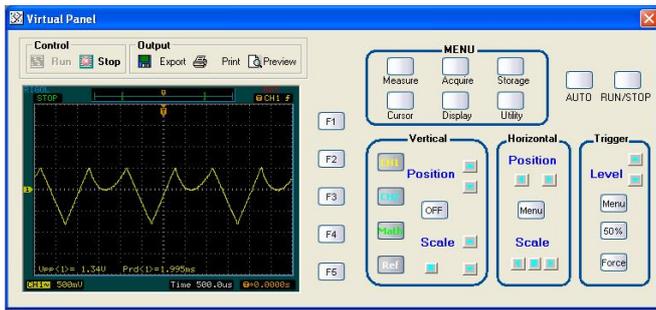


Fig 5 DSO output of the waveform

Thus we can see that the waveforms obtained were highly accurate.

II. Using microcontroller

Arbitrary waveform generation using DSP processor is not practically an optimized approach. The cost is too high as a DSP processor along with the required software costs in lakhs of rupees. So to make it more feasible and cost effective we can implement the same using microcontroller.

The block diagram is as shown below :

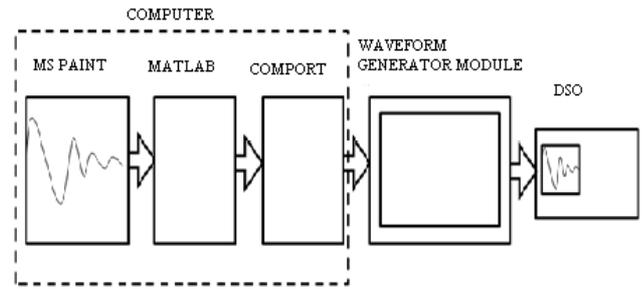


Fig 6 Block diagram of AWG using microcontroller

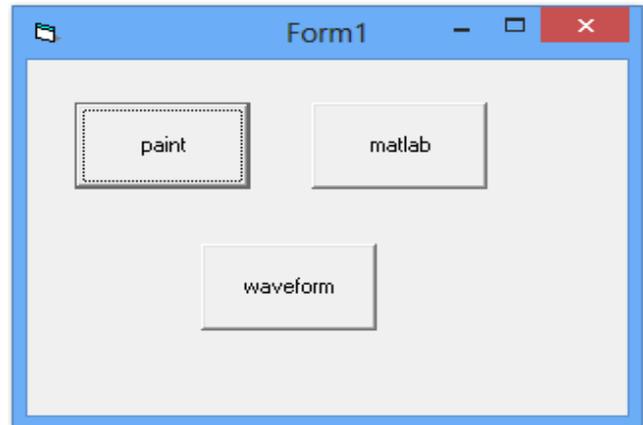
The amplitude samples obtained is sent serially over the RS-232 interface to the microcontroller. These amplitude samples are stored in the RAM of the microcontroller which acts as input to the DAC. Thus at the output we expect to get the desired waveform. This is one way of implementing the waveform generator. One big disadvantage is that the system is not a stand-alone one. One requires a computer for this.

In this again the waveform is drawn in MS paint using the same precautions as which were discussed above. Again the MATLAB program is used to get the amplitude samples. But all this process is integrated in one simple software implemented using VB i.e. Visual Basic.

There are three options on the VB GUI-Paint, MATLAB and Waveform. This is shown in the snap :

Fig 7 GUI for the user

So first we have to click on Paint and the Paint window opens up. Here you can draw the waveform which



you want to produce with the limitation that the height should be set to 255 as 8-bit DAC is used. Width can be any. Also the color attribute should be set to black and white. After making these changes we have to save this image with .bmp extension.

Then we have to press the next option i.e. MATLAB. When this is pressed a MATLAB exe file will open up. It is shown as below:

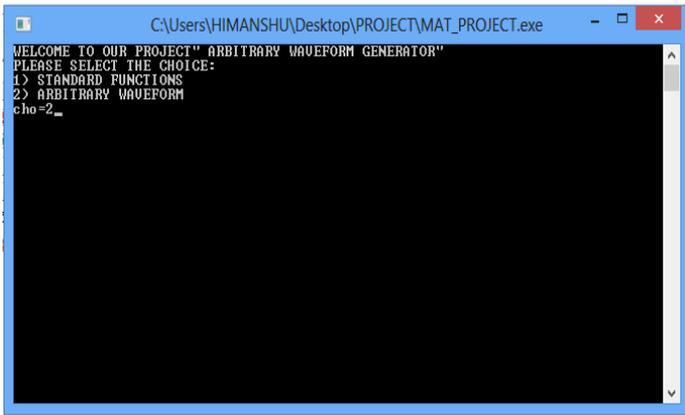


Fig 8 MATLAB exe file output

As we can see we get two option either a standard one or an arbitrary one. We first press the arbitrary option. This will open another window which shows the width of the waveform drawn in Paint. So if we want high resolution, then we can take the same number as width. Otherwise lower values can be used but the resolution will be less. Below snap will give a correct idea:

The practical result of some waveform drawn in Paint is shown alongside:

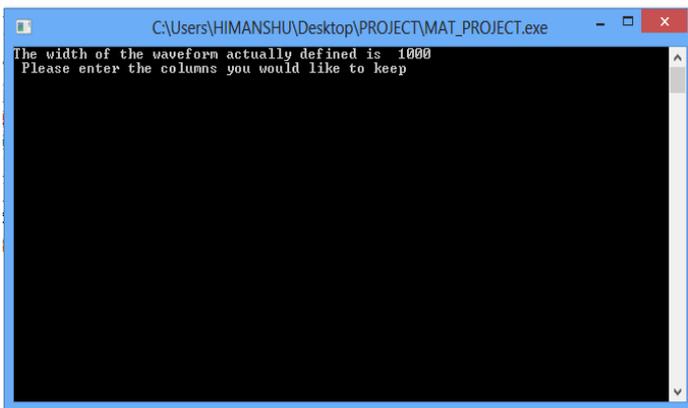


Fig 9 Window when Arbitrary chosen

1)

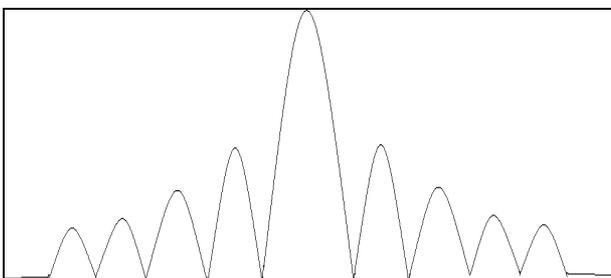


Fig 10 Waveform 1 using microcontroller

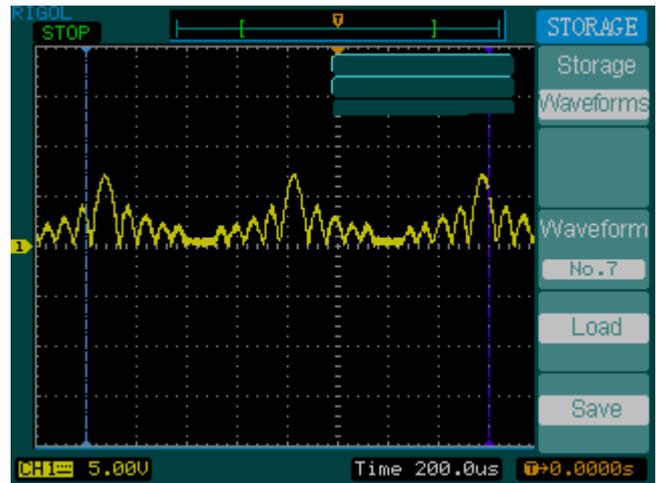


Fig 11 DSO output of Waveform 1

2)

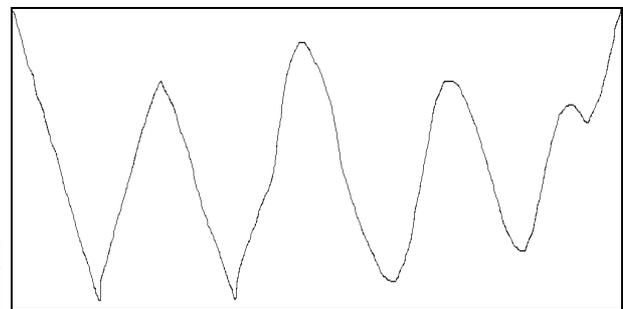


Fig 12 Waveform 2 using microcontroller

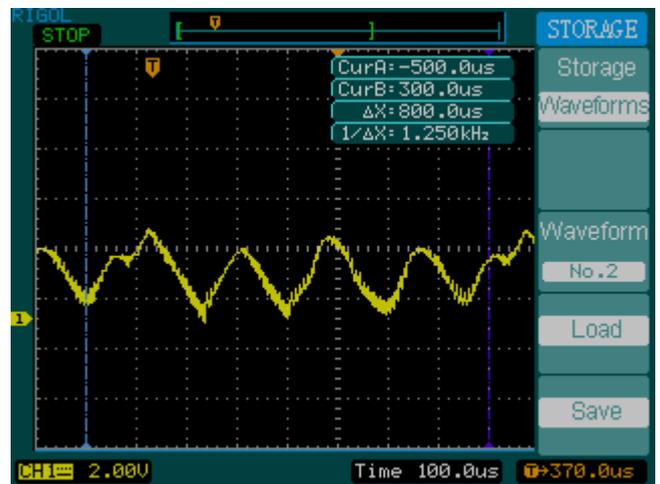


Fig 13 DSO output of Waveform 2

When standard waveform is chosen the option of sine and square is displayed. In this you have to give frequency as the input and the waveform is displayed. The output is shown below:

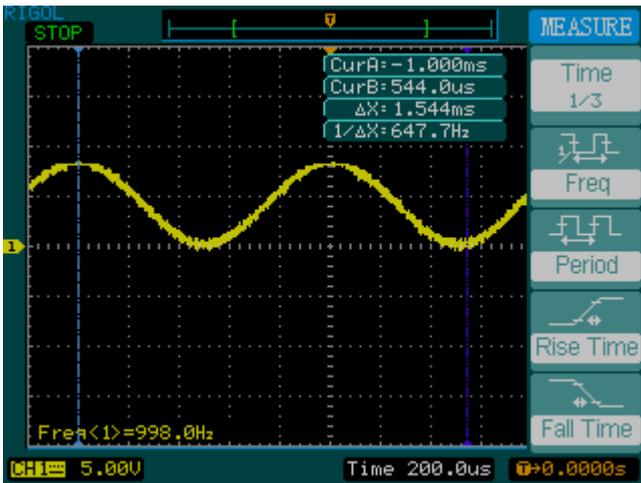


Fig 14 DSO output for sine wave

The third option is of Waveform . In this you can produce the audio file of the waveform drawn. This is one of the feature which is done by using a software Mp3 Editor for free.

Its output is shown below:

1)

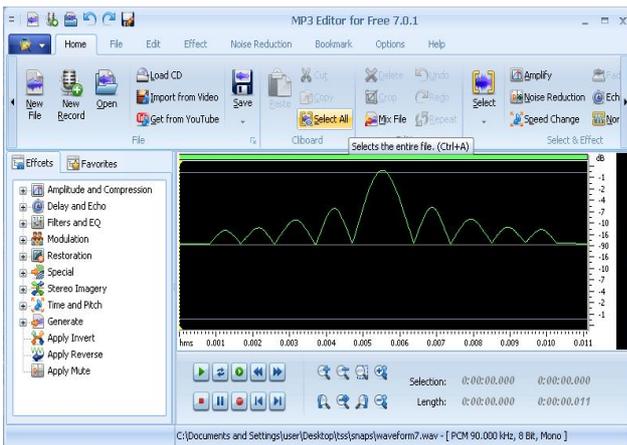


Fig 15 Audio output of Waveform 1

2)

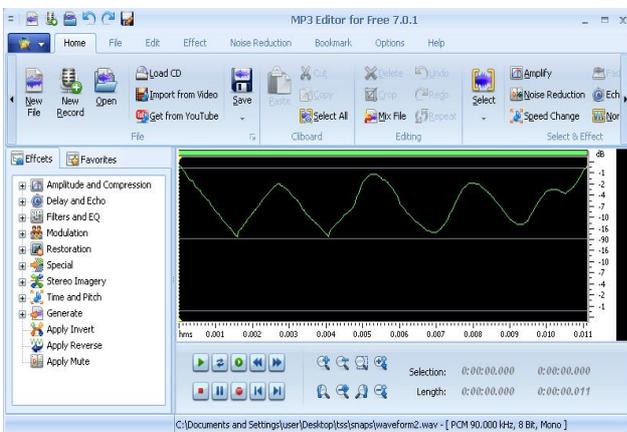


Fig 16 Audio output of Waveform 2

3)

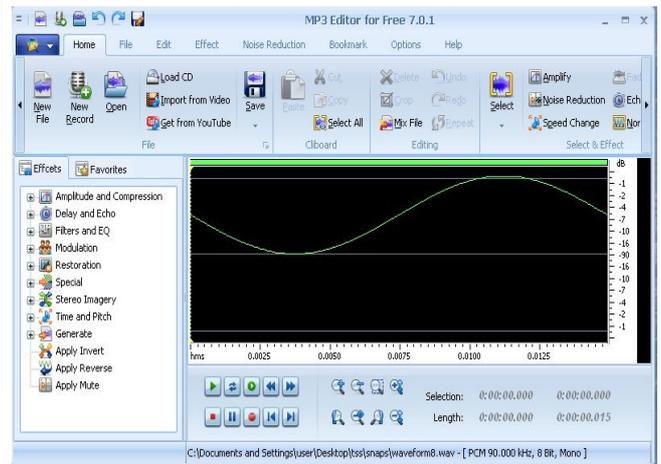


Fig 17 Audio output of sine wave

III. CONCLUSION

Thus, after seeing all this we can say that using our instrument we can produce any type of waveform. A possible extension of this can be made by using a touch-screen which can make it an independent entity. It will make away with the need for computer by using touch-screen as the visual element.

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