Ultrasound blood flow analysis using Zoom FFT

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***Abstract*- Blood flow is one of the most important functions of the body. It plays a vital role in supplying oxygen to brain and to other organs. Adequate amount of blood flow is very much important for every individual. Analysis of blood flow is essential in diagnosis of diseases. There are various methods used in the field of medicine to analyze blood flow but the cost is so high and poor people cannot make use of it. Our idea is to make it a cost efficient one. Zoom-FFT is a technique that can be implemented as it is simple and economical that could even detect blood clot. To monitor the flow of blood in our body, ultrasound is used. This implementation of ultrasound using Zoom FFT could be achieved with a VLSI chip where data encryption is quiet easier and analysis is done better.**

***Index terms*- Blood flow, Zoom FFT, diagnosis, data encryption**

I.INTRODUCTION

Transducer is used for analyzing the blood flow [1] by passing ultrasonic wave of high frequency. It is operated by Doppler principle, here we use MATLAB. Even though we use MATLAB the output will not be good due to high resolution frequency of ultrasonic wave So, we use Zoom FFT for better resolution .It can be used to detect the blood clots. It can be achieved only through single VLSI chip where this system is cost and power efficient.

This research purposes:

1. Study of Bio-medical signal processing [1], [2].
2. Mixing the input signal to the base band frequency using Hilbert Transform [3], [4].
3. Finding the down sampling using decimation process [3]
4. Obtaining the spectrum output using fast Fourier transform [3], [4]
5. Simulation by Matlab/C. [5]
6. XILINX FPGA trainer kit does real time implementation. [9].

Sounds at frequencies above the audible range, to say above 20 KHz are Ultrasonic wave, in the megahertz range. These waves are widely used for the blood flow analysis.

II DOPPLER EFFECT PHENOMENA

A.FORMULA

A change in frequency or wavelength of a wave in a relation to an observer who is moving relative to the wave source if the distance between them greater or decreased. The frequency shift depends on density of medium and velocity .When an object is placed near the sound wave, the wave will be scattered (distracted) .An useful information will provide by using direct measurement of velocity about the dynamic property of medium. 1570m/s is considered as velocity of sound in blood a formula is given below:

$fp = f0 (V+V0)/V-Vs,$ → (1)

for both objects moving towards.

$fp = f0 (V-V0) /V+Vs$ → (2)

for both objects moving away from each other.

f0 : Actual frequency.
fp : Perceived frequency.
V : Velocity of wave.
Vs : Source velocity.
V0 : Velocity of observer.

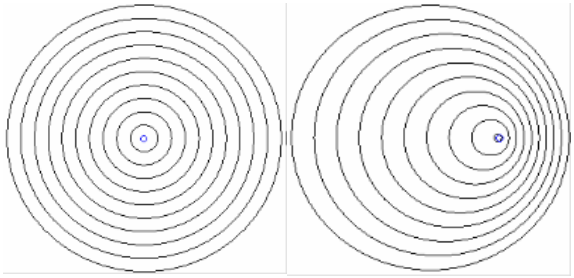


Fig 1.Perceived frequency change with respect to change in measuring media

By using this formula we get perceived frequency .A diagram is shown below which explain the process changes in measuring media with respective frequency. The Doppler effect is explained by simple example .This example say, a jeep pass on the bypass

road by blowing its horn at 400 Hz frequency if the jeep comes to you, you will hear greater than 400Hz or if the jeep is away from you, you will hear lesser than 400Hz.In analyzing the human blood flow Doppler effect is used to check the ultrasound range.

B. STEPS INVOLVED

- Sound generation: piezoelectric transducer is used to generate the ultrasonic sound wave
- The transducer number may vary from one to many
- A narrow wave beam is belonged
- To measure frequency and amplitude in real time, continuous mode of operation with no timed switching is used here.
- For frequency content of the blood flow, Doppler shift analysis is done.
- Color differentiation is used to create and plot images in 2 dimension display

III BLOOD FLOW ANALYSIS

A beam of ultrasonic waves is passed through a blood vessel at a shallow angle and its transit time is measured in ultrasound blood flow analysis [1]. The ultrasonic analyzers work on the principle of Doppler Effect. The piezoelectric transducer [6] is being excited by the oscillator operating at several megahertz frequency. The ultrasonic waves with a frequency F are allowed to pass through the exposed blood vessel from the transducer which is coupled to the wall of it. A small part of the transmitted energy is scattered back and is received by a second transducer arranged opposite to the first one .This scattering occurs mainly as a result of the moving blood cells. The reflected signal has a different frequency due to a Doppler effect.

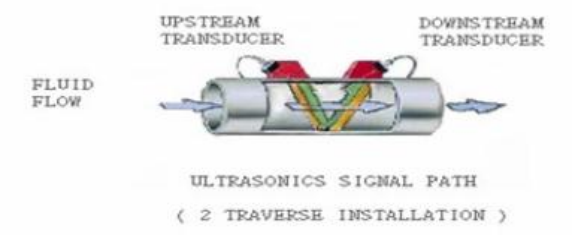


Fig 2: Transmitting and receiving signal through transducer for blood flow analysis

A.ZOOMING PHENOMENON

Zooming is usually done to find the difference in the blood flow. It can vary the blood flow depending on blood vessel size in normal and in clot cases[2]. If the clot is in the initial stage, there will be a slight variation in blood flow which could be easily identified.

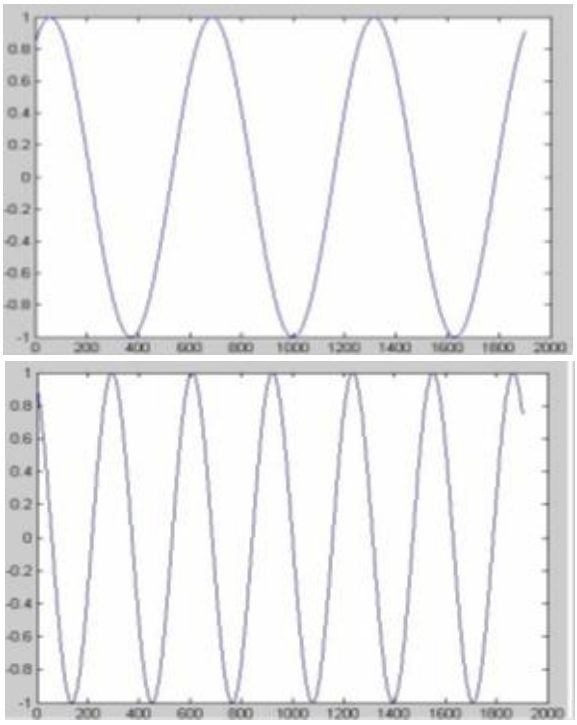


Fig 3: Frequency variation of blood flow

B.DETERMINATION OF FREQUENCY

During normal blood flow, frequency F1=f+df, where f is the frequency of the transmitted signal and df is the Doppler frequency of the reflected signal. Due to the blood flow in the blood vessel with clot the frequency F2=f+df+Df, where Df is an extra frequency component, the Doppler frequency due to the clot formation.

IV ZOOM FAST FOURIER TRANSFORM

The Process of Zoom FFT [8] involves an input signal which is mixed to baseband and then decimated preceded it to pass into the Standard FFT. To narrow frequency band that are set on higher frequency, digital down conversion technique is used to localize the standard FFT. When analyzing narrow band signals, sample rate is being reduced with the help of zoom fast Fourier transform.

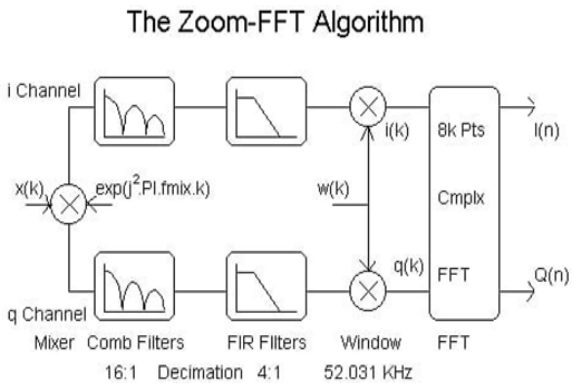


Fig 4: ZOOM Fast Fourier Transform

Zoom FFT is more efficient than FFT. This is used mainly to view in a certain frequency range around 10-11 kHz. To perform the process in a certain range or subset of frequency, this is very useful. The processing power is saved.

Zoom FFT offers higher range of frequency resolution over a specific bandwidth without computing the entire spectrum. Zoom is done as a part to increase the frequency measurement in the spectral analysis.

Traditional FFT spectrum analyzers had limitations in memory as it was not able to perform larger functions as it was implemented in hardware. Larger FFTs are economically possible as the memory limit has been increased. The high frequency resolution can be increased by applying the following methods.

1. Large FFT: The main advantage is that only small information is lost from signal during transformation. It gives information on amplitude, harmonics and phase.
2. Destructive zoom: Destructive zoom is method used for examination with greater details as it gives frequency information in a selected range.
3. Non-destructive range: This is a technique entire original time function is maintained

A.FREQUENCY TRANSLATION

Frequency translation is a process of transferring a signal from one part of frequency axis to other part. To get a proper response of input signal high frequency is translated to low frequency[4]. The output arrived is as follows,

cos(A-B) = cos(A)cos(B)+sin(A)sin(B). –(1)

i.e, cos(2000-1900) = cos(2000) cos(1900) + sin(2000)

sin(1900). = cos(100).

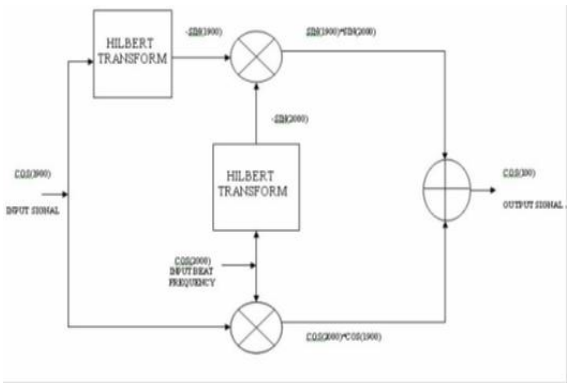


Fig 5: Block diagram of frequency translation

Thus the input wave, which has frequency 1900Hz is translated into 100Hz.

B.DISCRETE HILBERT TRANSFORM

Logically Hilbert transform is data acquired by phase shift of 90°where sine become cosine and vice versa[1],[4].

Equation-(2) gives the frequency translating function.

N-1 f(n) = (1/N) _ [1-(-1)m-n]f(m)cot(m-n)(_/N)

m=0 -(2)

Decimation:

Resampling at discrete instances the already sampled wave

we get equation-(3).

N-1

Y (m) =_h (k) x (Mm-k), M=decimation factor. k=0 -(3)

FFT:

The Fast Fourier Transform (FFT) is an algorithm that efficiently contains the frequency domain .Eq.4 gives the FFT

Equation.N-1

X(k) = _ x(n)e-j2 _nk/N 0<k<N-1 -(4) n=0

Advantages:

Advantages of ZOOM FFT Technique

1. Wider spectral range
2. Frequency domain resolution is high
3. Hardware cost is low

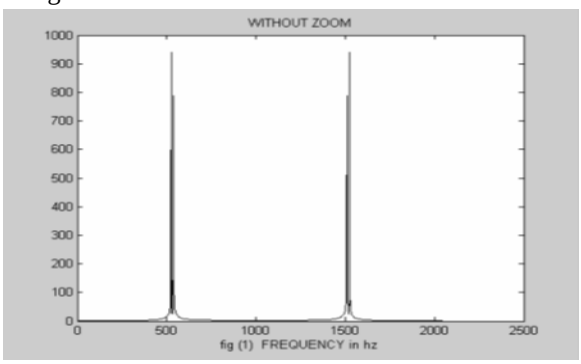
C.XILINX AND MATLAB

Matlab, simulink and stateflow are use to design and stimulate algorithms and then generate code for Xilinx FGPAs using HDL (Hardware Description Language) coder. Using Matlab, simulink and Xilinx

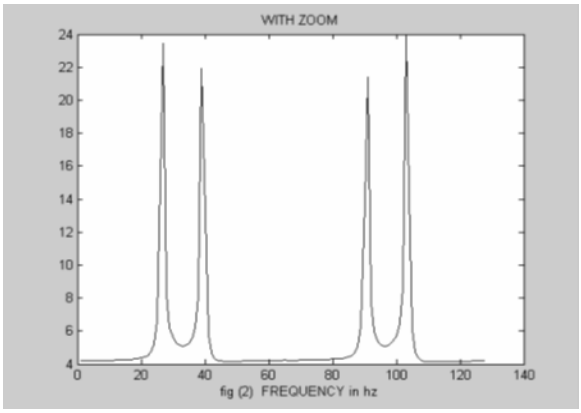
library of bit /cycle true designers can design and stimulate a system. Hardware description language code is automatically generated through this tool mapped to Xilinx pre-optimized algorithms. Thus abstract representation of a system-level representation can be designed by the designers and transform this single source code into gate level representation. Design verification is enabled and also provides automatic generation of a HDL test bench.

V CONCLUSION

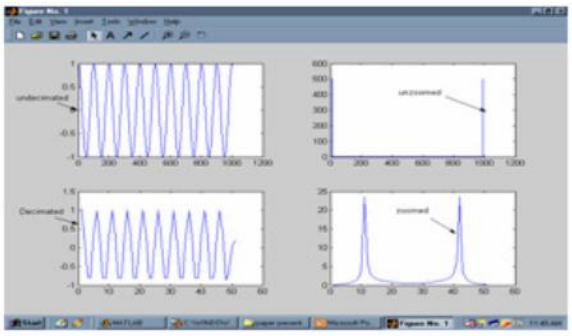
The real examination of the frequency of wave is shown below, fig (a), (b) shows the experiment done using the Piezo electric ultrasonic transducer.



(a)



(b)



(C)

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