Abstract-This paper discusses design and implementation of a portable oscilloscope. In Engineering Institute, oscilloscope is a very useful electronic instrument, have used for signal acquisition and analysis. These instruments are very expensive and students cannot afford to own one for educational purpose and have to be dependent on their institutes and laboratories. Moreover being bulky in size and a large weight added by Cathode Ray Tubes, they become very difficult to carry along. This paper intends to implement a very low cost portable oscilloscope has compact, low power, light weight. Principles of operation and implementation of oscilloscope depends on Analogue signal conditioning unit, Analogue to Digital Converter, Processing and Display unit. The data acquisition system (DAQ) is designed for sensing multichannel analogue inputs and for converting them into digital formats gives to processing unit and displayed on display unit.

Keywords- Analogue signal conditioning unit, Analogue to Digital Converter, Processing and Display unit.

1. INTRODUCTION

In Engineering Institute, oscilloscope is a very necessary instrument for signal acquisition and analysis. It stands out from other analogue measuring instruments because of its visual representation which aids in understanding the nature of a signal to a better depth. However, these devices are costly and out of reach of a student outside the laboratory hours. There are different instruments used like oscillators, signal generators and multi-meters. These instruments have disadvantages in form of their bulky size and high cost. So, these instruments should have small size, low cost and user should movable. Considering this fact into account, we had an idea of developing a low-cost solution, which will be an alternative to the traditional measuring and signal generating devices available in the market. Oscilloscopes are working on principles of operation and implementation of oscilloscope depends on Analogue signal conditioning unit, Analogue to Digital Converter, Processing and Display unit. The data acquisition system (DAQ) is designed for sensing multichannel analogue inputs and use an ADC to converter analogue voltages to binary representation. An analogue waveform is digitally sampled, processing and displayed onto the screen (GLCD, Computer Monitor etc). The processor of measured signal can be finished by friendly graphical interface such as the collection, analysis, display, data storage and so on. Digital oscilloscopes have become popular for signal acquisition and analysis. Because of their essential high-input impedance, digital oscilloscopes can be used for analysis of both analogue and digital circuits with high accuracy. Digital oscilloscopes have a PC connectivity feature which allows users to store data in PC for further analysis.

There are many systems available already which implemented for measuring and signal generation purpose. Those systems are Cathode Ray Oscilloscope (CRO), Digital Storage Oscilloscope, Analogue Storage Oscilloscope, PC based Oscilloscope (PCO), Analogue Signal Generator etc. The idea was to develop a low-cost, affordable, plug-in kind of data acquisition and Oscilloscope that can be used with associated software and can make the expensive DSO redundant for elementary signal analysis purposes. The concept of low-cost PC based virtual oscilloscope is presented in [1].These digital oscilloscopes are very fast, accurate and easy to build. They need a PC to process and display their data .The necessity of a PC is eliminated and integrated the processing and display unit in a single microcontroller [4]. A low cost portable oscilloscope for educational platforms using a programmable system on chip[3] implemented using a PSoC 4 device and a Nokia 5110 LCD screen. Sound card-based virtual instrument technology, through the program processing of the collected data by sound card under Lab VIEW environment, this paper designed a low-cost virtual oscilloscope system[6]. System built using msp430, Bluetooth module, USB converter and android Smartphone [9].
2. BACKGROUND WORK

Digital Storage Oscilloscope (DSO) is better than Cathode Ray Oscilloscopes due to its size and efficiency and the ability to store data. But considering the price, it is very expensive for students and amateur hobbyists. Moreover it is an industrial type oscilloscope with high resolution and tons of features which are not required to students. In recent times, the idea of a Web-based virtual laboratory has led to the development of a variety of virtual instruments, including virtual oscilloscopes. However, many of the virtual oscilloscopes do not come with data acquisition hardware and expensive Portable Oscilloscopes are already in the market but the availability of these oscilloscopes is not yet seen in all countries and not used in all institutes. There were many projects done on low cost portable oscilloscope. Different types of methodologies present in recent years on portable oscilloscope as follows.

A low cost device for both generation and measurement of electrical signal used in any basic electrical experiment[1]. The instrumentation industry is moving steadily and quickly in the direction of virtual instrumentation. Virtual instruments are centered on a PC, used with as little specialized hardware as possible to link it to the devices it must measure/control. In recent times, digital storage oscilloscopes (DSOs) have been implemented with the added feature of PC connectivity, such that the signal can be stored in the PC for later analysis. Virtual instrumentation is known for its flexibility, modularity, and low cost. A data acquisition device using the computer parallel port has been implemented with full analogue interface and 8-bit analog-to-digital converter with associated control-logic and timing circuitries. The data acquisition system (DAQ) is designed for sensing analogue inputs and for converting them into digital formats before transferring them to the PC. The digital data is stored in the PC memory and displayed on the PC screen; the provisions are kept for processing the data as well. The user-friendly GUI enables teaching the students about the basic functions of an oscilloscope, such as amplitude and time settings. In addition, several other functions for data-storage, display, analysis, and printing can also be demonstrated. The user specifications of the developed system have been set up in accordance with the requirements of common under-graduate-level laboratories in electrical, electronics, and computer engineering courses. The interface circuit hardware has been developed with few affordable electronic components for conversion and processing of the analog signal in the digital form before being acquired by the PC.

A low cost low power MSP430 microcontroller and is able to connect to an Android smartphone via Bluetooth [9]. Nowadays, every person have smart phones, tablets and other mobile devices [10]. Smart phones have enough screen sizes to display results in form of waveforms. Processing power of smart phones increasing day by day and it is good enough to evaluate different data and to analyse it. Mobility of user maintains due to different wireless communication options of smart phones. Smart phones have enough processing power to evaluate data and to analyse it. Smart phones have different wireless communication options like Bluetooth, Wi-Fi. MSP430 is low cost and have different low power modes. It has inbuilt DMA controller and can support many number of peripherals. Android OS is used on different smart phones mainly, which is open source and it is easy to develop any application on it. So, application build on android so that different instruments are used as a single device. Many people have smartphones in their pockets so is obvious to use such a device to plot some measured data on their screens which are large enough to evaluate analog or digital signals. They have enough processing power to analyse signals from harmonic content, distortion, noise, vibration and other point of view. The main benefits of the wireless connection are that the measurement can be evaluated and visualized on the screen without losing the mobility of the user. This is a very useful feature for a lab instrument System built using msp430, Bluetooth module, USB converter and android Smartphone. Results show that Bluetooth device is pairing with android device and so Bluetooth module can communicate with android device and data can be transferred from microcontroller to the android device using UART serial communication.

Sound card-based virtual instrument technology, through the program processing of the collected data by sound card under Lab VIEW environment, this paper designed a low-cost virtual oscilloscope system [6]. The virtual oscilloscope designed in this
paper consists of initialization, data collection and storage, data measurement and processing, etc. Virtual oscilloscope adopts data acquisition circuit and computer to capture the waveform, then uses the graphical user interface to simulate the oscilloscope control panel to process and display the collected signal. As the commercial data acquisition card are too expensive, not suitable for using as cheap, large batch, and high degree of flexibility instrument that universities teaching need. Sound card, as a audio signal acquisition system that standard configured in multimedia computer, is able to achieve signal acquisition. Therefore in this paper, sound card used as a data collection tool, and then apply the Lab view as a development platform to design a low cost, high flexibility virtual oscilloscope. Using module for the design, all the modules are designed by LabVIEW which is a graphical programming tool. In this paper, they select LabVIEW of American NI as the software development platform. LabVIEW is a graphical programming language and development environment, it is widely accepted by research laboratory and industry.

3. PROPOSED SYSTEM

Proposed system of a low-cost portable oscilloscope design and development depends on Arduino and Graphical Liquid Crystal Display (GLCD). An Atmel microcontroller is use for data acquisition and then will be displayed as a waveform on a GLCD screen. This project will design and develops to achieve the same functionality that old oscilloscopes have. Principles of operation and implementation of oscilloscope depends on Analogue signal conditioning unit, Analogue to Digital Converter, Processing and Display unit. The data acquisition system (DAQ) is designed for sensing multichannel analog inputs and for converting them into digital formats gives to processing unit and displayed on display unit. The input from the analog signal condition unit is directly connected with the Analog IN pin in the Arduino UNO. In this project, only two channel oscilloscope will make but more channels can be added farther by connecting multiples of Analog Signal Condition Units with unused analog IN pins. This would make the system more complex. To avoid complexity of the system maximum of two channels is preferred. The input stage of the oscilloscope consists of components which allow the user to adjust the gain and DC offset of the input signal. We will provide mathematical function on it. The probe of the oscilloscope reads the voltage wave signal, sends it to the input of the oscilloscope, which is designated to pin. The other part of the probe is connected to ground. The oscilloscope then converts the signal from Analog to Digital data, which is then saved to a buffer. The trigger sets the time sweep based on the number of signals sampled. The voltage signal is displayed on the GLCD as a two-dimensional graph of voltage against time.

![Block Diagram](image)

This Oscilloscope displays waveshape almost accurately as a traditional oscilloscope. Beyond the limit the waveshape gets distorted as the ADC of the Arduino has some limitations and the ADC generates its own noise.

Flow Chart:

In flow chart of firmware first we declare all the variables and then initialize Graphical LCD. The input from the analog signal condition unit is directly connected with the Analog pin in the Arduino UNO. Arduino Uno have in-built analog to digital converter. It converts analog signal comes from signal conditioning unit into digital signal. This digital data store to RAM. Then Changes has been done as per the requirement of the user and then display the data on the Graphical LCD. This process runs continuously as signal conditioning unit get analog input.
Hardware Implementation:

Hardware is made connecting the Analog signal conditioning unit with the input of channel input of the Arduino UNO and Arduino UNO output to the GLCD. Power supply is given to graphical LCD, Atmega microcontroller. Then in build 10 bit ADC converts analog signal into digital signal. User can adjust the toggle switch as per requirement. Graphical LCDs is 128 X 64 so there are only 64 dots in each column. We need only 8-bit to plot data those applications where both character and graphical representation are required. To interface this LCD with microcontroller, two registers (Input and Output register) are provided in the LCD. These registers are selected by the combination of RS and RW signals.

JHD12864E GLCD:

Here we are using JHD12864E Graphical LCD. This LCD has a display format of 128x64 dots with yellow-green color backlight. It works on +5V. This LCD uses two KS0108 controllers.

The 128x64 LCD is divided into two equal halves with each half being controlled by a separate KS0108 controller. Such LCDs (using KS0108 controller) involve paging scheme, i.e., whole LCD is divided equally into pages. For selecting the halves we have two pins named is chip select. Graphical LCD is mainly used in many applications like mobile phones, video games, lifts as a display. GLCD is divided into two equal halves.

4. Test and Results

Input from signal conditioning unit given to analog pin of Arduino and convert analog date into digital. This data stored and process for shows on GLCD in the form of waveform. The project has been checked and analyzed by giving different waves of different frequency and waveform is obtained in the GLCD. As we give input from function generator like sine wave, triangular wave. It has been tested with signals of different frequencies and found that it works well with frequencies up to 10Hz to 7.7kHz with sampling rate 10,000 samples/sec without any signal distortion.
Waveform is showing on GLCD screen. Also displays Peak value of signal, maximum value, frequency, volts/div etc. Using control panel user can give

5. Conclusion
This embedded system can be used to analyze low frequency signal and amplitude voltage. The final product is a fully operational oscilloscope that allowed the users to adjust the gain and offset of an input signal and view it in GLCD via Arduino. Due to small size it is easy to handle and operate, therefore this system can be used in research purposes and development. Despite of some measurement limitations, we believe that this flexibility gives this oscilloscope a unique ability to sample waveforms of various frequencies at a good fidelity. There are some limitations in input range and frequency, but as considered a preliminary Oscilloscope it has necessary factors and parameters to lie within expected ranges.

6. References