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A Review on Wireless Oscilloscope Powered by Android

Bhagyashree D.Hatwar[*1], Prof.A.C.Wan[2]
[*1,2] S.S.B.T, Bambhori, Jalgaon, India
khushihatwar@gmail.com

Abstract

The normal operation of any signal measuring device, is to take an input and display on a screen so as to measure it & for further processing.Unfortunately, these devices are too bulky and are not readily available except in electronic laboratories.

Now-a-days, the Android phone series are widely used. Keeping its familiarity and wide applications in mind, we chose to make a handy device for measuring input signals. We can further upgrade many applications on the android as new versions are launched regularly. This is a primary step of measuring signals, further we can work on signal processing which is a never ending stream, with a bright future. With the right coding techniques, we could work on Wavelet transforms which is replacing Fourier transform and is going to be the future of image and signal processing.

This paper presents an oscilloscope implemented using new technology, with low power consumption. It is a Bluetooth embedded device which will capture input voltage signals and transmit them to an external device, such as a smart-phone, running the Android operating system. Since the device is wireless it can make use of the Smartphone's display and processing power.

Keywords: Android, Bluetooth, Oscilloscope

Introduction

Portable oscilloscopes currently in the market are very expensive, less power efficient and have small low resolution displays. This paper presents the design and implementation of a low cost, portable, light-weight; low power, dual-channel oscilloscope, consisting of a hardware device and a software application. The device is equipped with a Bluetooth module to provide connectivity to a device with Bluetooth, running the Android operating system (OS), in order to display the waveforms.

Android OS is selected because there are a decent number of Android device users and most of these devices satisfy the requirements of the oscilloscope's software application. The hardware device includes circuitry to capture the input voltage signals and an embedded Bluetooth module for transmitting the captured signal information to an Android device for displaying the waveform.

The Software application developed for Android receives the data transmitted from the hardware device and plots the waveform according to the display settings configured by the user.

These display configurations are transmitted to the hardware device once they are set by the user, and are used by the hardware device to set the sampling rate and the values of samples.

For optimal use of the available bandwidth, the application provides two modes of operation, namely single channel mode where only channel 1 is operational and dual channel mode where both channels 1 and 2 are operational.

The user can select a mode from the application, which in turn sends a message to the microcontroller which then changes the sampling frequency accordingly: a higher sampling rate for single channel and half of that for dual channel [4].

Related Work

The implementation of an oscilloscope with Bluetooth was previously reported, by Yus in 2010 [1]. It is an open source prototype project called the "Android Bluetooth Oscilloscope", which consisted of a Bluetooth enabled transmitter circuit to send data to an Android phone which draws the waveforms on its screen.

The transmitter circuit uses Microchip's DsPIC33FJ16GS504 and an LMX9838 Bluetooth 2.0 SPP module. The maximum input voltage to the circuit is +8 V to -8 V. However, there is no mention about the bandwidth of the device. Furthermore, it is stated that the application had been tested only with a Samsung Galaxy GT-i5700 Spica (rooted Android

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2.1 OS) phone.Secondly, the related work is also observed in [2] where the authors have given the methodology about how actually the system works [4].

System Overview

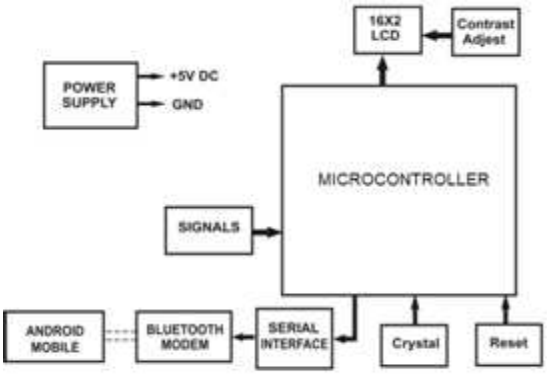

Fig.3.1.Block Diagram of Overall System

Block Diagram Description

i)Microcontroller:

From previous experience we knew that a microcontroller would be essential to serve as the brain of our system by controlling all other IC's. In our case, a Microcontroller would be necessary to sample the input data and process it. Moreover it would also be required to convert the data coming to data which follows UART protocol as majority of the Bluetooth have only UART ports.

Therefore we decided that any microcontroller we considered must have the following features.

1. A multi-channel on-chip ADC for input sampling.
2. A UART port (to communicate with Bluetooth).
3. A good amount of on-chip RAM for storing the samples.
4. Low power consumption (Portable device).
5. Small physical package (take up less board space).
6. Should be easily programmable.
7. Low cost.

For our work, we proposed to choose micro-controller AVR Atmega 16.Now Following are the reasons of choosing AVR micro-controller.

1. AVR microcontroller is 8-bit on chip system with RISC (Reduced Instruction Set Computer) command system.
2. The most of commands are performed in one clock cycle.
3. In AVR microcontroller reading next command is done during execution of previous command. So the overall number of commands in 1 second is almost equal to working frequency.
4. It differs from other microcontrollers that it requires less power in higher frequencies.
5. AVR microcontroller has 32 general purpose registers.
6. PIC's have one general purpose register so called accumulator.
7. And comparing to similar PIC microcontrollers AVR's have more advanced architecture that allows running one instruction per clock cycle while PIC microcontrollers run one instruction in 4 clock cycles.

High Endurance Non-volatile Memory

• 512 Bytes EEPROM
• 1K Byte Internal SRAM and Write/Erase Cycles: 10,000 Flash/100,000 EEPROM

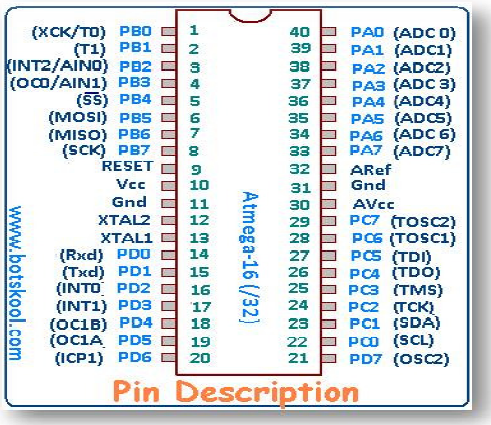

Fig.3.2. Pin Description of AVR Atmega 16

ii) Wireless Communication

According to our initial design specifications, we were required to have a two way communication link between our remote device and the display device. A lot of the potential external devices were looked at Including Laptops, PC's, smart phone based on Windows, OS, Android, etc. All of them had either a built in Wi-Fi module or a Bluetooth module or both. Thus in order to make our product more adaptable with these external devices it was decided to limit our communication options to Bluetooth and IEEE 802.11 (Wi-Fi). Both of these communication methods were analysed separately and keeping our system requirements in mind, we tried to determine which method would serve our needs better.

iii) Bluetooth:

Bluetooth Wireless technology is a short range communications technology intended to replace the cables connecting portable or fixed devices. It transmits data via low-power radio waves. Bluetooth technology has the ability to handle both data and voice transmissions simultaneously. The key

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features of the Bluetooth technology are robustness, low power, and low cost.

a) Frequency Spectrum: 2.45 GHz (between 2.402 GHz and 2.480 GHz).

b) Interference: A number of household devices, including baby monitors and cordless phones also take advantage of the same radio-frequency band as the Bluetooth.

c) Range: 10m (32 Feet)

d) Data Rate: The version HC05 can support a data transmission rate of up to 3 Mbps.

e) Power: Bluetooth technology is designed to have very low power consumption. The most commonly used Class 2 Bluetooth transmitter uses around 65mW of power.

f) Cost: A USB Bluetooth HC05 adapter is available in the market for $17.We had several Bluetooth options available to us if we decided to use Bluetooth transmission in our device.

g) System Power: We set a target of using devices operating a minimum voltage levels preferably 5V [3].

The proper selection for our work is Bluetooth module HC05, because of following features:

Master and slave mode can be switched.

h) Master role: It has no function to remember the last paired salve device. It can be made paired to any slave device.

i) Pairing: The master device can not only make pair with the specified Bluetooth address, like cell-phone, computer adapter, slave device, but also can search and make pair with the slave device automatically.

j) Multi-device communication: There is only point to point communication for modules, but the adapter can communicate with multi-modules.

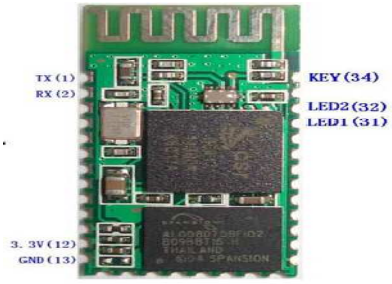

Fig.3.3.HC05 Bluetooth module

iv) BLUETOOTH CONNECTIVITY:-

The Android platform includes support for the Bluetooth network stack, which allows a device to wirelessly exchange data with other Bluetooth devices. The application framework provides access to the Bluetooth functionality through the Android Bluetooth APIs. These APIs let applications wirelessly connect to other Bluetooth devices, enabling point-to-point and multipoint wireless features.

Using the Bluetooth APIs, an Android application can perform the following:

- Scan for other Bluetooth devices
- Query the local Bluetooth adapter for paired Bluetooth devices
- Establish RFCOMM channels
- Connect to other devices through service discovery
- Transfer data to and from other devices
- Manage multiple connections[3]

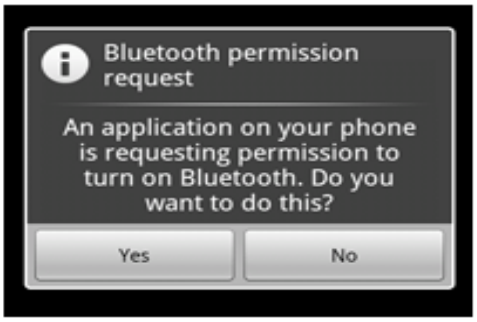

Fig.3.4.Bluetooth Connectivity

v) Android Smartphone

Android is hailed as "the first complete, open, and free mobile platform."[5]

i) Complete: The designers took a comprehensive approach when they developed the Android platform. They began with a secure operating system and built a robust software framework on top that allows for rich application development opportunities.

ii) Open: The Android platform is provided through open source licensing. Developers have unprecedented access to the handset features when developing applications.

iii) Free: Android applications are free to develop. There are no licensing or royalty fees to develop on the platform. No required membership fees. No required testing fees. No required signing or certification fees. Android applications can be distributed and commercialized in a variety of ways.

Share

With new versions of Android OS coming every few months we would like to select a version which is quite popular. We will target the Android Version 2.1 Éclair and above. As per statistics android version 2.1+ covers 67% of the total Android Devices being used. The 2.1 Platform also provides with many more Application Package Interfaces such as Bluetooth SDAP and CANVAS API. These API allow us to graphically design our software with less knowledge of the actual core JAVA coding.

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Fig.3.5.Android Applications on various Platforms [5]

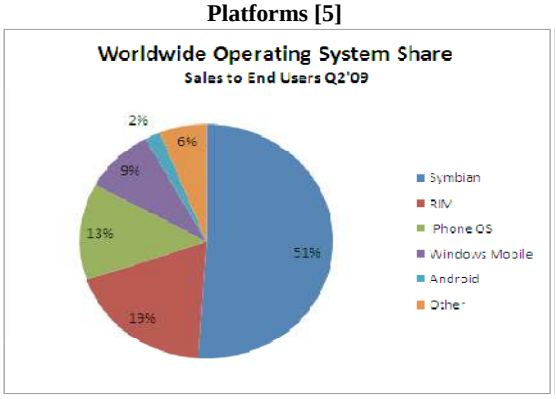

Fig.3.6.Worldwide Android System

Usage share:

Version

Distribution	API level	
1.5 *Cupcake*	3	0.3%
1.6 *Donut*	4	0.7%
2.0, 2.1 *Eclair*	7	6%
2.2 *Froyo*	8	23.1%
2.3.x *Gingerbread*	9-10	63.7%
3.x.x *Honeycomb*	11-13	3.3%
4.0.x *Ice Cream Sandwich*	14-15	2.9%

Fig.3.7.Overall Usage of Android

Android is a software stack for mobile devices that includes an operating system, middleware and key applications. The Android SDK provides the tools and APIs necessary to begin developing applications on the Android platform using the Java programming language.

Applications

Android will ship with a set of core applications including an email client, SMS program, calendar, maps, browser, contacts, and others. All applications are written using the Java programming language.

Processing Algorithm

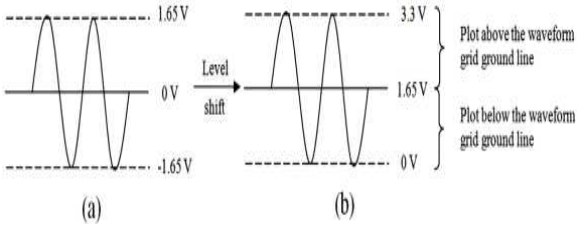

Fig.4.Processing Algorithm [4]

When the signal is plotted on the waveform grid it should look like Figure 5 (a), centered on zero. Therefore, as in Figure 5 (b), the voltages greater than 1.65 V should be above the ground line in the waveform grid and those less than 1.65 V to be below the ground line.

Essentially, this process is what is used to convert the 10-bit sample to 8-bits to represent the 200 levels on the screen. Figure shows this processing algorithm.

```
Voltage = ADC reading x ADC resolution
    if ADC reading < 512
        Voltage = ADC midvoltage - Voltage
        New voltage = (Voltage x Pixels per division) / Volts per division
        Transmit value = Display ground point + New voltage
            if Transmit value > 230
                Transmit value = 230
    else
        Voltage = Voltage - ADC midvoltage
        New voltage = (Voltage x Pixels per division) / Volts per division
            if New voltage >= Display ground point
                Transmit value = 0;
            else
                Transmit value = Display ground point - New voltage
```

Fig.4.2. Processing Algorithm [4]

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System Analysis

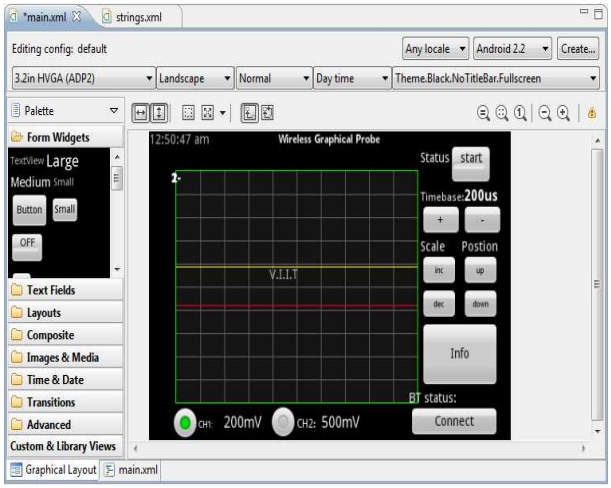

Fig.5.Resultant output window

Conclusion

This paper conveys the basic idea related to low-cost, portable, low-complexity Bluetooth embedded oscilloscope. This paper gives only the overview of the system, that how the system works.
The hardware device includes circuitry to capture the input voltage signals and an embedded Bluetooth module for transmitting the captured signal information to an Android device for displaying the waveform. The Software application developed for Android receives the data transmitted from the hardware device and plots the waveform according to the display settings configured by the user. Using Bluetooth module, higher data transmission is possible. Android based smartphone is most popular now. Android has emerged as a new mobile development platform, building on past successes and avoiding past failures of other platforms. Android was designed to empower the developer to write innovative applications.So, it can become a portable oscilloscope. Using further advancement, FFT can be obtained. Thus android based oscilloscope plays a vital role in the field of research.

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