Hardware and Software design of USB FM radio for PC: A Survey

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Abstract

FM radio is one of the popular entertainment channels in developing countries. Radio technology has been around for more than a century. There is a plug-in device which, when attached to a computer, can bring FM radio service to a computer . The plug-and-play FM receiver can be built using an FM receiver chip with a microcontroller or system on chip (SOC). The microcontroller acts as a USB device when communicating with the USB host and receives commands for operations such as channel scan, channel change, or to set output power level. This bus-powered plug-and-play FM receiver accessory can tune in to the local FM channel while an Universal Serial Bus based FM radio is a facility of to connect a FM station for a computer. An aim of a work is to develop an FM radio using computer peripheral known as the FM USB Radio. This design is for such type of hardware through which FM station can be heard by an audio system of computer. The system also provides facility such as channel scan, channel change, or to set output power level through a computer.

1. Introduction

Via radio waves, both AM and FM radio programs are transmitted over the air. Radio waves are an electromagnetic waves, it contains visible light, X-rays, gamma rays and others. These waves are all around us in different frequencies. Radio waves and light waves are same but are at a frequency our eyes are not sensitive. The carrier was discovered for electronic signals in 1856 in the world of radio transmission waves. James Clerk Maxwell's mathematical theory of electromagnetic pulses being sent through the atmosphere were the basis for the development of transmitters and receivers for voice and music broadcasting.FM radio waves are a result of these efforts. Maxwell discovered that when an electrical charge is combined with a magnetic pull, created a field that could pass through the air in the form of wave.A good example of how modulation works. A blank piece of paper is useless unless it is modulated. Someone must write or draw on the paper for it to communicate useful information. To make still air useful it is changed or modulated with voice data or music data .For radio communication modulation takes place in   the electromagnetic radiation or electricity in the air[5].

The next step was how to solve the problem of control of these electromagnetic waves in the evolution of radio. The discovery of the carrier signal made possible of attaching one electromagnetic wave to another in order to control its characteristics. Thus the theory of modulation of a sine wave was found, underlying principle of radio waves. The amplitude, frequency, and phase are three components of a sine waveform related to radio signal transmission of the wave. Amplitude and frequency are modulated to create controllable waveforms that can be transmitted, using the carrier signal. The discovery of altering waves with audio signals using either amplitude modulation (AM) or frequency modulation (FM) was the beginning of what is now known as AM and FM radio waves.
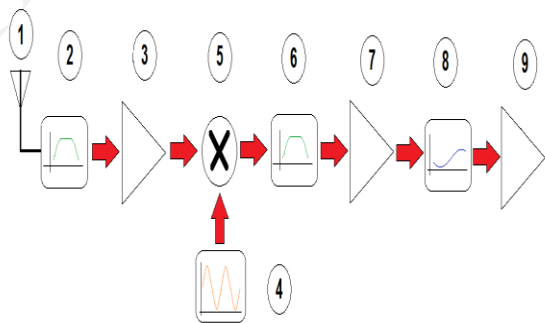

Fig.1 Block Diagram of an FM receiver [2]

Block Functions: 1 Antenna; 2. RF Filter; 3. Low Noise Amplifier; 4. Local Oscillator; 5. Mixer; 6. IF Filter; 7. IF Amplifier; 8. Demodulator; 9. Audio Amplifier

Many experimentation were started   into   radio frequency and signal broadcasting to change a carrier signal using audio data. A signal which is produced by FM radio waves, less affected by static charges than AM waves. An FM receiving antenna is able to receive signals with more fidelity and less interference. Thus signal quality is better than AM. An FM broadcasting transmitters began over very high frequency, used for voice communication and music broadcasting. FM broadcasting became more popular in the 1970s, as frequency bands that were earlier used for more dedicated broadcasting, such as standard tune stations, became the focus of new

broadcasts of the new harmonious styles. The superiority of the signal and the development of the music field itself resulted in an atmosphere crowded with competing FM radio waves[4].

An FM is a type of modulation which conveys information over a carrier wave by varying its frequency,while in amplitude modulation the amplitude of the carrier is varied while its frequency remains constant. In analog applications, the instantaneous frequency of the carrier is directly proportional to the instantaneous value of the input signal. This form of modulation is commonly used in the FM broadcast band.

2. The Proposed framework

The proposed framework consists of three components. The first component is FM radio receiver which is responsible for acquiring the data from FM station. The second one is a microcontroller with a built-in universal serial bus peripheral. The third component is a host PC, windows application of a PC plays the audio using the PC speakers[1]. Very fewer external components than many other solution are required because of the high level of system integration.Thus small sized
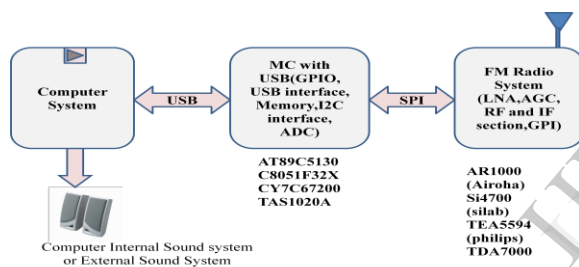

Figure.2 High Level Architecture of USB FM Radio for PC

3. System Description

3.1 FM radio receivers

The range of FM radio receiver chip is 88 to 108 MHZ.FM radio receivers have an ability to tune frequencies in steps of 50, 100, or 200 kHz. FM radio can also support radio data system which is called RDS and radio broadcast data system called RBDS. This plug and play device is completely programmable by host PC. In accumulation of transmitted audio data, RDS is used to receive text information, could incorporate the title of the song, name of the program being broadcast, or flash news for display. In case of emergencies, RDS can be used to transmit critical information[1].

The FM radio chip scans the complete FM band for available radio channels using band scan method. The radio then stores the strongest channel frequencies in its internal memory that can be read by

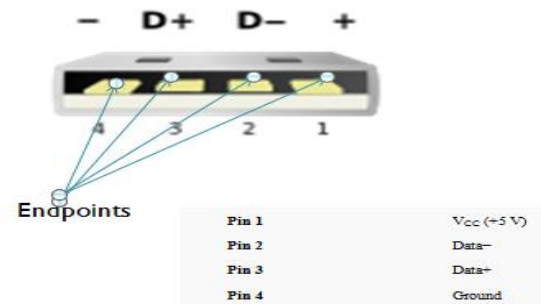the host microcontroller and that scanned signal is given to an audio pin of PC.

Figure.3 USB Pins [7]

3.2 Microcontroller.

Now a days with the initiation of recent programmable microcontroller, a fewer additional external components are required which are a few passive component to implement the complete design. The microcontroller sends information and receives status messages from the FM radio chip over an I2C port. The microcontroller connects to the host PC through the established USB interface.

When the FM radio receives a command to lock to a particular frequency, it outputs analog audio on specific pins. The analog output from the FM radio receiver is further processed by the SOC and the digitized audio is streamed over USB to the host computer. The power required for the FM radio chip operation is derived from the USB bus[1].The current required for most FM radio chip is typically a few milliamps or even less at 1.8V. This is well within the capability of USB bus and an acceptable level for a portable device.

The following resources are required in a microcontroller for an implementation.

3.2.1 Amplifier

An output of FM receiver is analog audio signal which is amplified using an amplifier,then is is fed the ADC in a SOC. The power of the analog audio output is improved .This ensures that the whole input range of the ADC is utilized ,thus a faithful reproduction of the audio at the output of the FM radio chip. The signal can be digitized using an ADC with a smaller input range. However, the smaller the amplitude of the signal, the more weaker it is to system noise.

3.2.2 Analog to Digital Converter

Analog to Digital Converter samples the analog output of the amplifier and converts it to a digital value. The sampling rate is decided with the Nyquist principle which states that the sampling frequency must be at least two times the maximum operating

frequency.

3.2.3 Communication protocol

To interface the microcontroller and FM receiver IC ,communication Protocol is used, such as I2C or SPI. If I2C is used, the microcontroller will act as the Master and the radio receiver chip will act as the slave. Commands to change the channel or to scan the FM band can be issued to the FM receiver chip from the I2C master over the I2C bus[8].

3.2.4 USB interface

USB is used to interface the host PC and the microcontroller. An USB interrupt endpoint is used to receive various commands from the host, such as channel scan, channel increase, channel decrease, etc. The digital data obtained from the ADC is transmitted to the host using an isochronous USB transfer mode. An isochronous transfer is ideal for this transmission as it is capable of maintaining reliable delivery time due to its guaranteed latency, allocated bus bandwidth, and need of error correction and handshaking.

3.3 A host PC

The host runs an application that serves as a front-end for controlling the radio receiver. A simple GUI can be created using standard Java or C, C++. Control objects such as buttons are provided to select channel, increase, or decrease channel position and so on.

The Front-End Host Application Form application in Windows is used to generate events upon requests from the user such as: Request for channel scan, Request for increment in channel, Request for decrement in channel etc.

4. Conclusion

Few studies combined both hardware approach and software based approach. We present a hardware consideration of a system which is used to get FM signal on a computer system without using the internet. In future we can add more facility like an improvement in audio quality with a use of more reliable microcontroller IC which can give an amplification of the analog audio, digitization, filtering, and streaming to a host and controlling the FM receiver efficient manner, recording of a songs etccompany wants to know how consumers feel about their products and services and those of their competitors Sentiment analysis can be developed for new applications. the techniques and algorithms used for sentiment analysis have made good progress, but a lot of challenges in this field remain unsolved. More future research can be done for solving these challenges.

6. References

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