Wireless Headphones with Active Noise Reduction

Aaron Andrews

Western Washington University
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Abstract

This design of a wireless headphone set is to allow mobility to its user while allowing them to indulge in audio entertainment that will have a reduced amount of interruption by ambient noise. It will incorporate the functions of a pre-existing Android OS device with media storage and Bluetooth technology to run a program application to control signals sent to the headset. The Headphones will use IEEE Bluetooth standards to connect and receive data from the device. An audio recording device will be attached to the outside of the headphone to monitor the ambient noise so that the headphones can generate a signal to counteract these recordings. The Headset will combine the modified and transmitted signals to create an audio sequence that will reduce the interference of external noise and send the combined signal to the output speakers.

Description

The design parameters for this project are to incorporate a wireless receiver module (Bluetooth Receiver, Figure 1) to communicate using Bluetooth from a variety of transmitters containing stored media files. An audio microphone (Ambient Microphone, Figure 1) will be attached externally to the headphones to capture signals from the environment and filter out frequencies unlikely to create interference determinable by the human ear (Analog Filtering, Figure 1). Both the Bluetooth receiver and the analog filtering circuitry will transmit their data to a microcontroller (MCU, Figure 1). A key constraint of the MCU is the data manipulation and computation timing, due to the fact that the headset will be required to record, modify and combine audio signals in real-time.

Furthermore, the MCU will need to meet the specifications to receive two audio signal inputs, include additional filtering, signal modification, signal mixing and output a signal to transducers (Speakers, Figure 1). All the functions of the headset will need to be powered by a portable power source. The headphones will incorporate an external physical switch and LED to allow the user to control the power to the device as well as know when it is turned on.

Figure 1: Wireless Headphones Block Diagram
In addition to the wireless headphones, a software application will be developed to run on android devices to control the transmittable media desired to be played by the headset (Android Bluetooth Transmitter, Figure 1). The application will give the user control to select, play and pause the media being transmitted.

Additional research is to be conducted as to which type of MCU would be most beneficial for this project. Those currently in consideration are digital signal processing (DSP) and field-programmable gate array (FPGA). Both have the capability to produce a successful product, depending on if a low powered application is available in the FPGA or if the DSP can streamline the necessary signal modifications to meet the real-time requirements.

Preliminary Standards

This device will incorporate the IEEE Std 802.15.1™-2005 Bluetooth standard to be a marketable product compatible with current devices. This will also provide the ability for the device to be updated to support the larger market of all Bluetooth devices. Other standards that will need to be addressed are the consumer electronic safety guidelines and specification outlined in BS EN 60065-1:202+A12:2011 and BS EN 60950-1:2006+A12:2011.

Benefits

This product is designed to support the average consumer in providing them with the ability to move around freely while enjoying audio entertainment that limits interruption from surrounding noises. Similar wireless headphones products are on the market and some models use active noise cancelation (ANC). Many directly comparable products, however, are either low quality or too expensive for a large percentage of consumers. The purpose of this project is to incorporate these features in a manner that is efficient and cost effective.

As there are a multitude of competitive products on the market the advantages and disadvantages vary over a large range. The simplest comparison aspect of wireless headphones is the cost. Though many wireless headsets can be purchased for a reasonably low price, the majority either incorporate passive noise cancelation (PNC) or none at all (Sennheiser RS 120 II $99, Beats $280). PNC headphones are typically a bulky design that only muffle ambient noises.

On the other hand, most of the headsets that produce respectable active noise cancelation are not cost effective (Parrot Zik $350, Sony MDR 1RBT $400). The downside to these devices is not the effectiveness, but their marketability. At this price it is not feasible for many consumers to enjoy this technology. This project attempts to bridge the gap between functional products and those that are cost effective.

In Summary, this device is designed to be a median product to what is currently on the market. The goal is to be available to a variety of users at a suitable price while producing an appropriate amount of ambient noise reduction. Though this project is not expected to beat the lowest competitive price, it is designed to use circuitry to reduce the surrounding noises that may cause interference while still remaining cost effective.
Impacts

The largest impact expected to be generated by this product is enable mass consumption. Current products leave a large gap between effective and affordable products in the current market of wireless ANC headphones. It can be anticipated that this product may generate a significant amount of sales by targeting a larger market share using design parameters of being convenient, cost effective and efficient.

Development and Demonstration

Production of the wireless headphones with noise reduction will require a large part of time to be dedicated to researching digital signal processing and the necessary components to obtain project goals. The key component of this project will be the MCU as it will need to perform real-time calculations on digital signals and quickly mix the computations with the transmitted audio that is desired. A large portion of time will be spent learning the onboard resources of the MCU and the parameters of its features to effectively carry out the procedures.

Another important aspect of this project is the development of the software application to run on Android devices. This application, or app, is required to connect the device to the headset and transmit the data selected. This process is important to demonstrate the versatility of the product and its functionality. Implementing basic media player functions, the app is designed to be a serviceable user interface to control the headphones media output.

Other components include a Bluetooth receiver, microphones capable of picking up the preferred range of audio to be filtered out and output speakers that generate a desirable audio signal. These components, though important, are readily available from a variety of locations and therefore are not trivial components to this project.

For the demonstration of this product a pre-constructed headset will be implemented with the previously described design to model a prototype headset. Though the compactness of the prototype may not be desirable or all-inclusive into a stylish packaging, the prototype is to display the functionality and ability of the project’s concept.