Active Noise Control in Air-ConditioningDucts

Dr.Ragab MohamedAL- Sair[1], Dr.HodaSolimanSiddiq[2],Mohamed Mahmoud Kamel Mahmoud[3]
Electronics and Communications Department,[1] El-Azhar University
[2,3]National Center for Housing& Building Research

Abstract: A proposed model is set up for a Noise-cancelling of air conditioning by means of active noise control. Essentially, this involves using a microphone, placed near the fan, and an electronic circuitry which generates an "anti-noise" sound wave with the opposite polarity of the sound wave of the microphone. This results in destructive interference, which cancels out the noise within the enclosed volume of the fan. The best sat is factory result was obtained at 2000 Hz equal 11 dB.

Keywords: Active noise; Noise cancelling; Electronic system; Sound pressure level.

1. Introduction

Heating, Ventilating, and Air Conditioning (HVAC) systems are often very noisy. And there is a need for decreasing the noise level. Passive noise control cannot give the satisfying result for low frequencies, it is too costly and it is not quit efficient [1-2]. Active noise control uses principle of destructive interference of the sound waves, e. g. in order to cancel undesired noise a sound wave with inverse sound pressure is generated, toachieve a large amount of cancellation, the anti-noise source must generate an inverted signal of original noise signal with great accuracy [3-4].
Active Noise Cancellation (ANC) is a method for reducing undesired noise. ANC is achieved by introducing a canceling "anti-noise" wave through secondary sources. These secondary sources are interconnected through an electronic system using a specific signal processing algorithm for the particular cancellation scheme [5].
Noise Cancellation makes use of the notion of destructive interference. When two sinusoidal waves superimpose, the resulting waveform depends on the frequency amplitude and relative phase of the two waves. If the original wave and the inverse of the original wave encounter at a junctionat the same time, total cancellation occur.
The challenges are to identify the original signal and generate the inverse without delay in all directions where noises interact and superimpose [6-7]. Signal cancellation of two waves 180° out of phase is shown in Figure 1.

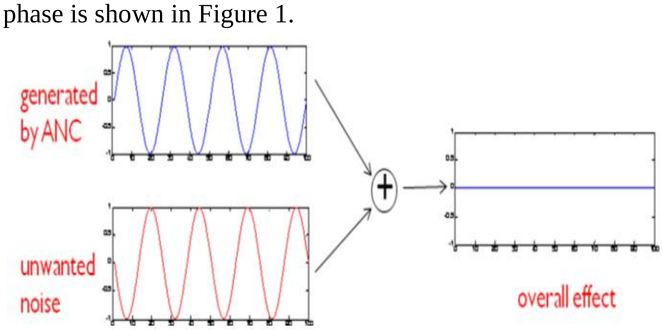

Figure 1: Signal Cancellation Of Two Waves 180° Out of Phase.

2. Experimental validation

2.1Model of active noise control in a duct

The present paper depends on the research of the Active Noise Cancellation of Michael Benoit [8].Where thisresults and discussion of the construction of the circuit were moderately successful.In the firstexperimental was chosethe model and measured the result inside this model as shown Figure 2.

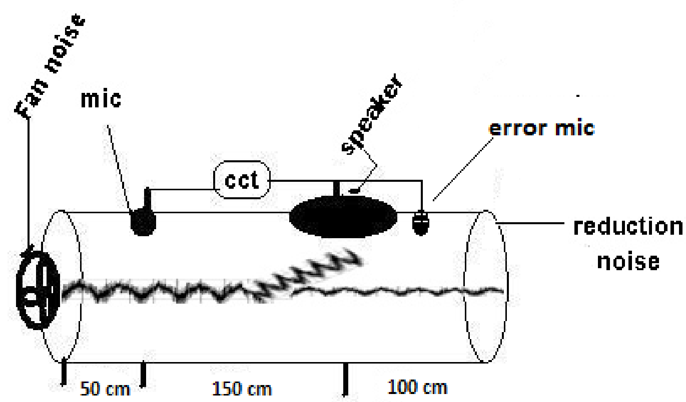

Figure 2. Model Used.

2.2Simulation of active noise control in a duct

In the presented ANC circuit the truly infinite benefits of the oscilloscope, measurements, Proteus software to check our circuits are cancellation or not and designingare considered where the input and the output are sum to cancel the noise as shown in Figure 3.

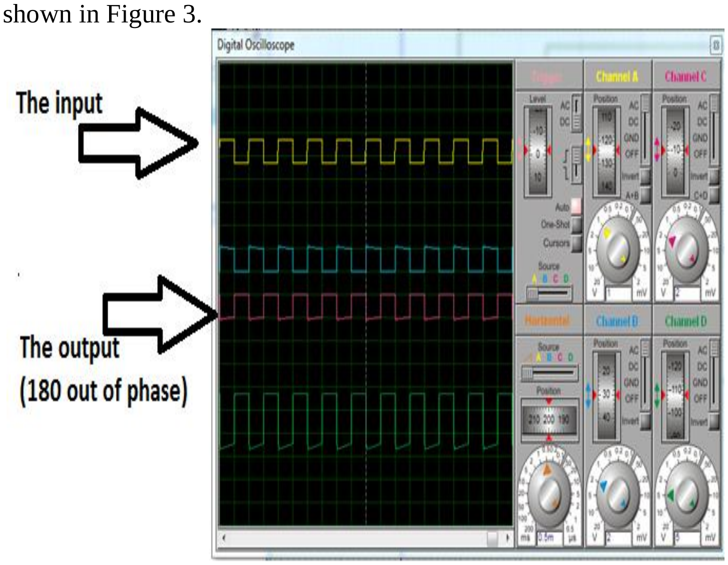

Figure 3. Active Noise CancellationSimulation.

2.3 Description ANC circuit

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The circuit in the noise canceling system can be divided into three stages with mic circuit, each stage containing an op-amp circuit that alters the analog signal in a unique way, as shown in Figure 4.The first section in the circuit schematic is a non-inverting preamplifier, the second a phase inverting op-amp configuration, and the third is a signal-summing amplifier. These three main components of the circuit lead into one another consecutively, modifying the signal as it passes through the device.That type of op-amp configuration can be easily modified to add a summing feature by the inclusion of another load So that if we add this circuit to do the same work without that summing are shown in Figure 5.

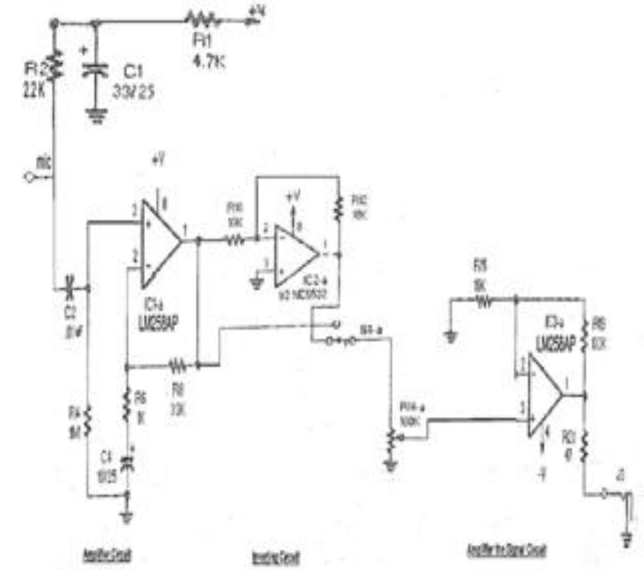

Figure 4. Active Noise Control in a Duct.

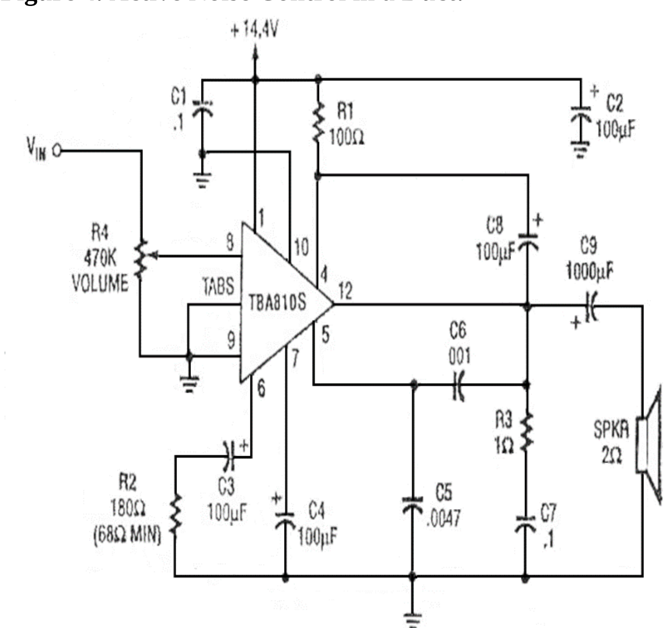

Figure 5. Audio Power Amplifier Circuit.

A considerable amount of broadband noise is produced in ducts such as exhaust pipes and ventilation systems. A relatively simple feed forward control system for a long, narrow duct as illustrated in Figure 6. A reference signal x (n) is sensed by an input microphone close to the noise source before it passes a loudspeaker. The noise canceler uses the reference input signal to generate a signal y (n) of equal amplitude but 180◦out of phase. This anti-noise signal is used to drive the loudspeaker to produce a canceling sound that attenuates the primary acoustic noise in the duct.

The basic principle of the broadband feed forward approach is that the propagation time delay between the upstream noise sensor (input microphone) and the active control source (speaker) offers the opportunity to electrically reintroduce the noise at a position in the field where it will cause cancellation. The spacing between the microphone and the loudspeaker must satisfy the principles of causality and high coherence, meaning that the reference must be measured early enough so that the anti-noise signal can be generated by the time the noise signal reachesthe speaker.Also, the noise signal at the speaker must be very similar to the measured noise at the input microphone, meaning the acoustic channel cannot significantly change the noise. The noise canceler uses the input signal to generate a signal y (n) that is of equal amplitude and is 180◦ out of phase with x (n). This noise is output to a loudspeaker and used to cancel the unwanted noise.

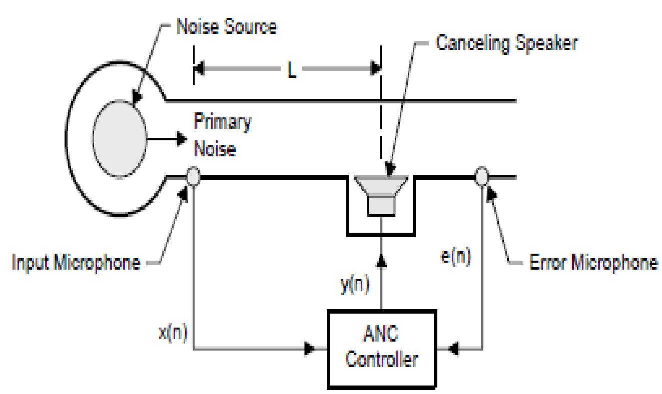

Figure 6. Single-Channel Broadband Feed forward ANC System in a Duct.

The error microphone measures the error (or residual) signal e (n), which is used to adapt the filter coefficients to minimize this error. The use of a downstream error signal to adjust the adaptive filter coefficients does not constitute feedback, because the error signal is not compared to the reference input. Actual implementations require additional considerations to handle acoustic effects in the duct [9].

3. Result and Measurement

Result and Measurement of active noise cancellation show that, the maximum cancellation reading are 5 and 11dB at 1000 Hz and2000 Hz, So the frequency response is at 2000 Hz and while other band frequency at 125 Hz, 250Hz, 500Hz, 4000Hz, 8000Hz have smallercancellation,as shown in table 1 and figure 6.

Table1: Sound pressure frequencies sound with and without cancellation ANC

Band frequency (Hz)	125	250	500	1000	2000	4000	8000
Sound pressure level (dB) without ANC	73.4	73.3	75.3	78.4	85.8	75.3	63.1
Sound pressure level (dB) with ANC	73.0	73.2	74.7	73.8	74.4	69.5	62.0

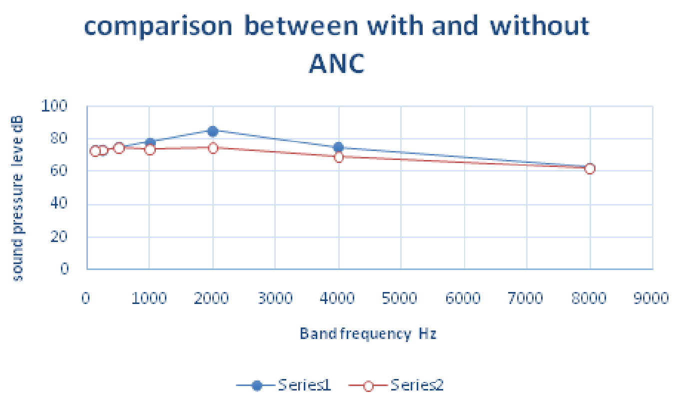

Figure 6.Comparison between Relationship Band frequency and sound pressure level with and without ANC

4. Conclusions

The work in this paperinvolved of control system for input following and disturbance rejection. Starting off with a characterization of the plant, a suitable compensation network was designedto stabilize the plant and achieve a maximum noise cancellation level of 11 dB and operating in a cancellation bandwidth of 100 Hz - 8 KHz. The feedback system designed Was tested for its closed loop frequency responses for noise, and the results to match theoretical design predictions within the limits of plant variation. A maximum reduction in noise level of 11dB at 2000 Hz was recorded. The closed loop noise response was found to be improved over the plant in terms of a flatter response for bass inputs.

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ix. *These considerations are discussed in the section Algorithms for ANC Systems, page 13.*