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CPU FAN NOISE CONTROL BY ACTIVE NOISE CANCELLATION

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Abstract

Active Noise Cancellation (ANC) has been growing in integrated circuits for controlling the speed of cooling fans in CPU and other electronic equipment. Small electrical fans are cheap and have been used for cooling electronic equipment for more than half a century. However, in recent years, the technology of using these fans has evolved significantly. This paper will describe how and why this ANC evolution has taken place and will suggest some useful approaches for the designer.

Key Words: Active Noise Cancellation, CPU, Fan noise, noise control

1. Introduction

The trend in computer, particularly consumer electronics, is towards smaller products with enhanced combinations of features. Consequently, lots of electronic components are being shoehorned into very small form factors. An obvious example is the notebook PC. Thin and lite notebook PCs have shrunk significantly, yet their processing power has been maintained or increased. Other examples of this trend include projection systems and set-top boxes. In the notebook PC, much of the heat is generated by the processor; in the projector, most of the heat is generated by the light source. This heat needs to be removed quietly and efficiently. The quietest way to remove heat is with passive components such as heat sinks and heat pipes. However, these have proved insufficient in many popular consumer electronics products—and they are also somewhat expensive. A good alternative is active cooling, introducing a fan into the system to generate airflow around the chassis and the heat-generating components and efficiently removing heat from the system. A fan is a source of noise, however. It is also an additional source of power consumption in the system—a very important consideration if power is to be supplied by a battery. The fan is also one more mechanical component in the system, not an ideal solution from a reliability standpoint.

An exhaust fan mounted inside the cpu box runs continuously to discharge the hot air into the box in order to cool down the equipment inside the computer. The fan generated low-frequency tonal noise into the cpu box, which caused noise levels in a very large area of the cpu to be over 55 dB(A). Low-frequency noise is very penetrating, travels very long distances and is difficult to attenuate using traditional passive control measures. Passive noise control technology, which usually involves using absorptive materials or noise partitions, can be bulky, ineffective and rather expensive at low frequencies. Active Noise Control (ANC), on the other hand, can be very efficient and relatively cheaper in reducing low-frequency noise.

2. Active Noise Cancellation Technology

Active Noise Control is a technology using noise to reduce noise. It is based on the principle of superposition of sound waves. As demonstrated in Fig.1, a sound wave is travelling in space. If another sound wave having the same amplitude but opposite phase to the first sound wave can be created, the first wave can be totally cancelled. The second sound wave is named “antinoise”. Although the idea of ANC is not new, its practical application had to wait for the

recent development of sufficiently fast electronic control technology.

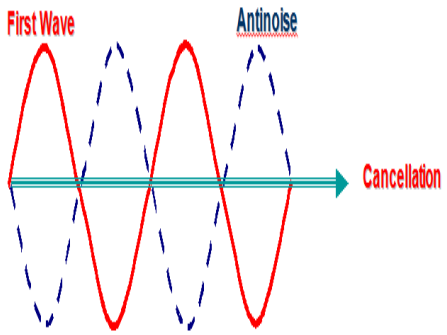

Figure 1. The mechanism of active noise cancellation control.

A basic feed-forward active noise control consists of a reference sensor, an electronic controller, a fan and an error sensor, as shown in Fig. 2. It works as follows: the reference fan picks up the information of the primary noise field and sends it to the electronic controller; the controller then drives the control fan to radiate the antinoise; the error fan examines the control performance and modulates the controller to the best result.

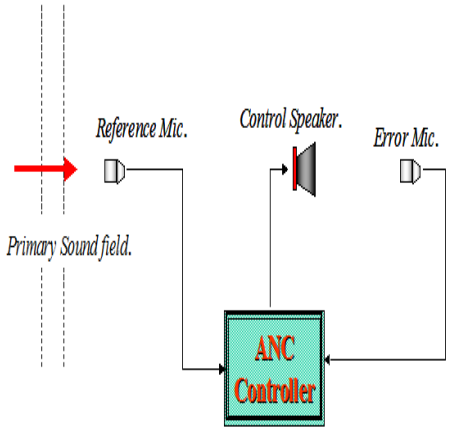

Figure 2. Basic structure of a feed forward active noise control system

3. Active Noise Cancellation Control System Installation

A short square duct made of 2 mm thick galvanized panel with dimension 0.45 m ×0.45 m × 0.9 m is installed over the outlet side of the fan, as shown in Fig. 3. The inside walls of the duct are lined with 1.5 cm thick wool blanket. There are two functions of the duct: (1) to achieve sound attenuation for broadband noise and (2) to provide a platform on which to place the control loudspeaker.

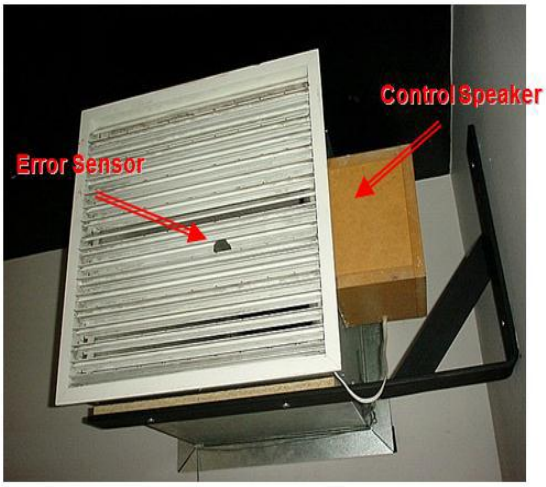

Fig 3. Error microphone and loudspeaker mounted in duct.

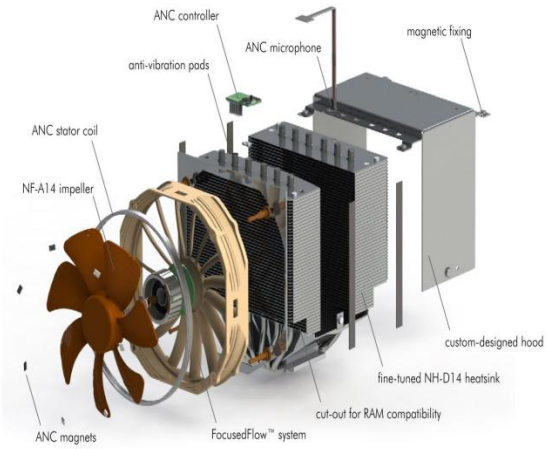

Fig 4: Active Noise Cancellation Installation Device

The reference sensor of the control system is an infra-red (IR) sensor, which is fixed at the inlet side of the fan. The IR sensor picks up the blade rotating speed as the reference signal. The advantage of choosing the IR sensor is that it avoids the noise contamination from the control end.

The core part of the adaptive feed forward control system is a DSP-based controller, which is fixed in a box and placed inside the computer room, as shown in fig 5.

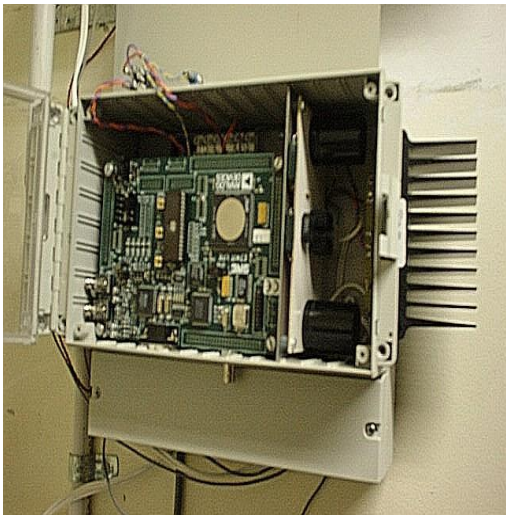

Fig 5. Controller box located inside the computer room.

4. Noise reduction

The result at the error fan with the ANC switched 'ON' shows that the tonal noise cancellation is significant, as shown in Fig. 3. Reductions of more than 30 dB at 82 Hz, 25 dB at 164 Hz, 15 dB at 246 Hz and 15 dB at 328 Hz can be achieved. Such results would be practically very difficult and expensive to achieve from passive noise control methods.

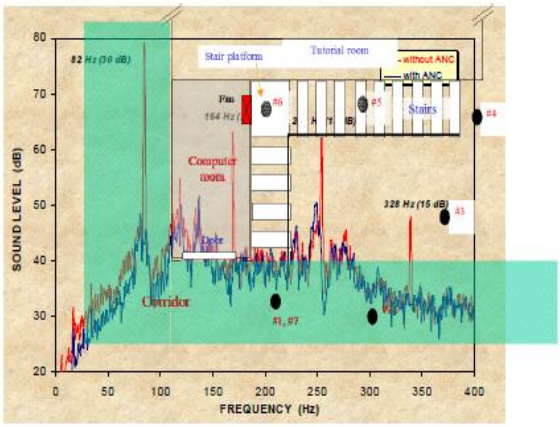

Fig 6. Noise reduction measurements

5. Conclusion

Active noise cancellation technology is very effective technology for reduce the noise in the cpu fan, also reduced the heat dissipation in the cpu box. Due to heat reduce it increase the efficiency of the central processing unit. Also increase the life of all IC and microsprocessor.

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