ACTIVE NOISE CONTROL OF ENGINE EXHAUST SYSTEM

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ABSTRACT

THIS THESIS DESCRIBES TWO ACTIVE NOISE CONTROL (ANC) SYSTEMS FOR REDUCING UNDESIRED NOIS -E IN ENGINE EXHAUST SYSTEMS.THE FIRST PROPOSED CONTROLLER IS BASED ON THE ADAPTIVE FILTER USING FILTERED-X LEAST MEAN SQUARE (FXLMS) ALGORITHM,WHILE THE OTHER IS A FIXED CONTROLLER OF GAIN-SCHEDULED ACTIVE CONTROL TECHNIQUE FOR BROADBAND ATTENUATION WITH THERMAL EFFECTS. BOTH OF THE CONTROL ALGORITHMS ARE IMPLEMENTED ON A DIGITAL SIGNAL PROCESSOR (DSP) USING FINITE IMPULSE RESPONSE (FIR) FILTER.IN THIS ANC CONTROL STRUCTURE,ACOUSTIC FEEDBACK IS DE -CREASED BY USING DIRECTIONAL MICROPHONES AND BACKWARD CONTROL LOUDSPEAKER IN HARDWARE DES -IGN, AND CONSIDERING COMPENSATION OF FEEDBACK NEUTRALIZATION FILTER IN CONTROL ALGORITHM. EXPERIMENTS ARE CARRIED OUT TO EVALUATE THE ATTENUATION PERFORMANCE OF TWO PROPOSED ACTIVE CONTROL SYSTEMS FOR SYNTHETIC RANDOM NOISE SOURCE, CENTRIFUGAL FAN NOISE AND ENGINE EXHAUST NOISE, RESPECTIVELY. THE RESULTS OF EXPERIMENTS INDICATE THAT THE ADAPTIVE FILTER AND GAIN-SCHEDULED ANC CONTROLLER ARE EFFECTIVE IN SUPPRESSING THE EXHAUST END NOISE OF PROPOSED SYSTEM. THE EXPERIMENTAL COMPARISON AND ANALYSIS OF PROPOSED ANC CONTROLLERS ARE ALSO DESCRIBED IN THIS THESIS.

Keywords : ACTIVE NOISE CONTROL, DIGITAL SIGNAL PROCESSOR, ACOUSTIC FEEDBACK, ENGINE EXHAUST SYSTEM

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REFERENCES

1 M. L. MUNJAL,1986,ACOUSTICS OF DUCTS AND MUFFLERS WITH APPLICATION TO EXHAUST AND VENTI -LATION SYSTEM DESIGN, NEW YORK: JOHN WILEY AND SONS. 2 L. HUANG, 2000, "A THEORY OF REACTIVE CONTROL OF LOW-FREQUENCY DUCT NOISE," JOURNAL OF SOUND AND VIBRATION, VOL. 238, PP. 575-594. 3 A. SELAMET AND Z. L. JI, 2000, "ACOUSTIC ATTENUATION PERFORMANCE OF EXPANSION CHAMBERS WITH TWO END-INLETS/ONE SIDE-OUTLET," JOURNAL OF SOUND AND VIBRATION, VOL. 231 , PP. 1159-1167. 4 A. CUMMINGS, 1999, "HIGH FREQUENCY RAY ACOUSTICS MODELS FOR DUCT SILENCERS," JOURNAL OF SOUND AND VIBRATION, VOL. 221, PP. 681-708. 5 P. LUEG, 1936, PROCESS OF SILENCING SOUND OSCILLATIONS, U.S. PATENT NO. 2043416. 6 M. J. LIGHTHILL, 1952, "ON SOUND GENERATED AERODYNAMICALLY. I. GENERAL THEORY," PROCEED -INGS OF THE ROYAL SOCIETY OF LONDON, VOL.

A211, PP. 564-578. 7 S. M. KUO AND D. R. MORGAN, 1996, ACTIVE NOISE CONTROL SYSTEMS: ALGORITHMS AND DSP IMPL -EMENTATIONS, NEW YORK: JOHN WILEY AND SONS. 8 P. A. NELSON AND S. J. ELLIOT, 1992, ACTIVE CONTROL OF SOUND, LONDON: ACADEMIC PRESS. 9 R. F. FONTAINE LA AND I. C. SHEPHERD,1983, "AN EXPERIMENTAL STUDY OF A BROADBAND ACTIVE ATTENUATOR FOR CANCELLATION OF RANDOM NOISE IN DUCTS," JOURNAL OF SOUND AND VIBRATION, VOL. 91, PP. 351-362. 10 J. C. DOYLE AND B. A. FRANCIS, 1992, FEEDBACK CONTROL THEORY,NEW YORK:MACMILLAN PUBLISH -ING COMPANY. 11 M. T. S. TOMIZUKA AND K. K. CHEW, 1989,"ANALYSIS AND SYNTHESIS OF DISCRETE-TIME REPETI -TIVE CONTROLLERS," ASME JOURNAL OF DYNAMIC SYSTEMS, MEASUREMENT, AND CONTROL,VOL. 111, PP. 353-358. 12 M. R. BAI AND H. LIN, 1998, "PLANT UNCERTAINTY ANALYSIS IN A DUCT ACTIVE NOISE CONTROL PROBLEM BY USING THE THEORY," JOURNAL OF ACOUSTICAL SOCIETY OF AMERICA, VOL. 104, PP. 237-247. 13 M. L. MUNJAL AND L. J. ERIKSSON, 1988, "AN ANALYTICAL, ONE-DIMENSIONAL, STANDING-WAVE MODEL OF A LINEAR ACTIVE NOISE CONTROL SYSTEM IN A DUCT," JOURNAL OF ACOUSTICAL SOCIETY OF AMERICA, VOL. 84, PP. 1086-1093. 14 R. H. CABELL AND C. R. FULLER, 1999, "A PRINCIPAL COMPONENT ALGORITHM FOR FEEDFORWARD ACTIVE NOISE AND VIBRATION CONTROL," JOURNAL OF SOUND AND VIBRATION, VOL. 227, PP. 159 -181. 15 M. R. BAI AND D. J. LEE, 1997, "IMPLEMENTATION OF AN ACTIVE HEADSET BY USING THE ROBUST CONTROL THEORY," JOURNAL OF ACOUSTIC SOCIETY OF AMERICA, VOL. 102, PP. 2184-2190. 16 R. L. CLARK AND D. S. BERNSTEIN, 1998, "HYBRID CONTROL: SEPARATION IN DESIGN," JOURNAL OF SOUND AND VIBRATION, VOL. 214, PP. 784-791. 17 J. HONG AND D. S. BERNSTEIN, 1998, "BODE INTEGRAL CONSTRAINTS,COLLOCATION,AND SPILLOVER IN ACTIVE NOISE AND VIBRATION CONTROL," IEEE TRANSACTIONS ON CONTROL SYSTEM TECHNOLOGY, VOL. 6, PP. 111-120. 18 D. G. MAC MARTIN AND S. R. HALL, 1991, "STRUCTURAL CONTROL EXPERIMENTS USING AND POWER FLOW APPROACH," JOURNAL OF SOUND AND VIBRATION, VOL. 148, PP. 223- 241. 19 J. D. WU AND M. R. BAI, 2001, "APPLICATION OF FEEDFORWARD ADAPTIVE ACTIVE NOISE CONTROL FOR REDUCING BLADE PASSING NOISE IN CENTRIFUGAL FANS," JOURNAL OF SOUND AND VIBRATION, VOL. 239, PP. 1051-1062. 20 A. ROURE, 1985, "SELF ADAPTIVE BROADBAND ACTIVE SOUND CONTROL SYSTEM," JOURNAL OF SOUND AND VIBRATION, VOL. 101, PP. 429-441. 21 J. D. WU AND M. R. BAI, 2001, "DEVELOPMENT OF A ZERO SPILLOVER CONTROLLER FOR BROADBAND CANCELLATION OF NOISE IN DUCTS," JAPANESE JOURNAL OF APPLIED PHYSICS, VOL. 40, PP.6634 -6640.