Structural Analysis and Performance Evaluation of Piezoelectric Inkjet-Heads

E-mail: 9314487@ mail.dyu.edu.tw

ABSTRACT

The purpose of this thesis is to make a study of characteristics of an inkjet-head, which actuated by a newly designed shear type piezoelectric actuator. Points of this thesis are: analyzing and forecasting of characteristics of the shear type piezoelectric actuator and the inkjet-head, performance evaluation of piezoelectric inkjet-head and experimental measurement of dynamic characteristics of piezoelectric actuator. As the influence of properties of piezoelectric actuator is toward the inkjet-head directly, a finite element model will be established first to make analyses of piezoelectric actuator. A structural, electrical and fluid coupling finite element model will be established secondly to analyzing influences of mass loading of ink on the diaphragm. Then a lumped element model of the piezoelectric inkjet-head system will be presented to obtain a transfer function of inkjet system. The transfer function is purposed to evaluating performance of piezoelectric inkjet-head, and to provide consultations for designing. Finally, an experimental measurement of dynamic characteristics of piezoelectric actuator is taken to provide contrast with system models.

Keywords : shear-type piezoelectric actuators, piezoelectric inkjet-heads, lumped parameter model, transfer function

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REFERENCES

[1] J. Brunahl, and A. M. Grishin, " Piezoelectric shear mode -drop-on-demand inkjet actuator," sensor and actuator A 101, -pp.371-382, (2002).

[2] W. Zhu, K, Yao, and Z. Zhang, " Design and fabrication of a -novel piezoelectric multiplayer actuator by thick-film screen -printing technology," sensor and actuator A 86, pp.149-153, (2000).

[3] A. V. Lemmo, D. J. Rose, and T. C. Tisone, " Inkjet dispensing -technology: applications in drug discovery," Current Opinion in -Biotechnology, (9), pp.615-617, (1998).

[4] G. C. Everstine, " A symmetric potential formulation for -fluid-structure interaction," Journal of sound and vibration 79(1), -pp.157-16, (1981).

[5] C. Conca, A. Osses, and J. Planchard, " Added mass and -damping in fluid-structure interaction," Comput. Methods Appl. -Mech. Engrg. 146, pp.387-405. (1997).

[6] W. C. Muller, " Simplified analysis of linear fluid-structure -interaction," International Journal for Numerical Methods in -Engineering, Vol. 17, pp.113-121, (1981).

[7] A. Bermudez, R. Duran, and R. Rodriguez, " Finite mlement -solution of incompressible fluid-structure vibration problems," -International Journal for Numerical Methods in Engineering, -Vol. 40, pp.1435-1448, (1997).

[8] N. J. Robinson, and S. C. palmer, " A model analysis of a -rectangular plate floating on an incompressible liquid," Journal -of sound and vibration, 142(3), pp.453-460, (1990).

[9] A. Ergin, and B. ugurlu, " Linear vibration analysis of cantilever -plates partially submerged in fluid," Journal of fluids and -structures, 17, pp.927-939, (2003).

[10] J. Brossard, and M. Chagdali, " Experimental investigation of -the harmonic generation by waves over a submerged plate," -Coastal Engineering 42, pp.277-290. (2001).

[11] M. R. Haddara, and S. Cao, " A study of the Dynamic -Response of Submerged Rectangular Flat Plates," Marine -Structures 9, pp.913-933, (1996).

[12] H. G. Davies, " Low frequency Random excitation of -water-loaded rectangular plats," Journal of sound and vibration, -15(1), pp.107-126, (1971).

[13] Y. Gu, and C. R. Fuller, " Active control of sound radiation from -a fluid-load rectangular uniform plate," J. Acoust. Soc. Am. -93(1), January, pp.334-345, (1993).

[14] A. Berry, " A new formulation for the Vibrations and sound -radiation of fluid-loaded plates with elastic boundary -conditions," J. Acoust. Soc. Am. 96(2), pt. 1, August, -pp.889-901, (1994).

[15] B. E. Sandman, " Motion of a three-layered elastic-viscoelastic -plate under fluid loading," J. Acoust. Soc. Am. Vol.57, No.5, -May, pp.1097-1106, (1975).

[16] M. K. Kwak, " Hydroelastic Vibration of Rectangular Plates," -Transactions of the ASME, Vol. 63, March, pp.110-115, (1996).

[17] J. Ro, A. Al, and A. Baz, " Control of sound radiation from a -fluid-loaded plate using active constraining layer damping," -Structural dynamics: recent advances, vol.2, pp.1257-1272,(1997).

[18] W. J. Daniel, " Performance of reduction methods for -fluid-structure and acoustic eigenvalue problems," International -Journal for Numerical Methods in Engineering, Vol. 15, -pp.1585-1594, (1980).

[19] K. L. Hong, and J. Kim, " New analysis method for general -acoustic-structural coupled systems," Journal of sound and -vibration, 192(2), pp.465-40, (1996).

[20] C.C. Sung, V. V. Varadan, X. Q. Bao, and V. K. Varadan, -" Active Torsional Vibration Control Experiments Using -Shear-Type Piezoceramic Sensors and Actuators," J. Intelligent -Material Systems and Structures, Vol. 5, pp.436 - 442, (1994).

[21] A. E. Glazounov, Q. M. Zhang, and C. Kim, " Torsional actuator -based on mechanically amplified shear piezoelectric response," -sensor and actuator A 79, pp.22-30, (2000).

[22] K. T. Hogskolan, " Operational properties of Piezoelectric -Shear-Mode Actuator," Department of Microelectronics and -Information Technology, Master Thesis, (2002).

[23] Q. Gallas, R. Holman, T. Nishida, B. Carroll, M. Sheplak and L. -Cattafesta, " Lumped Element Modeling of Pizeoelectric-Driven -Synthetic Jet Actuators," AIAA-2002-0125.

[24]   , "   -   ,"   , (2003).

[25] S, Timoshenko, and S. Woinowsky-Krieger, " THEORY OF -PLATES AND SHELLS," 2nd ed., Mcgraw-Hill Book Company, -London, pp.196-202, (1959).

[26] ANSI/IEEE Standard 177, Standard Definitions and Methods of -Measurement for Piezoelectric Vibrators, 1966.

[27] ANSI/IEEE Standard 176-1987, Standard on Piezoelectricity, 1988.

[28] R. E. Apfel, " Acoustic Lumped Element From First Principles," -Encyclopedia of Acoustic, pp.161-164, (1997).

[29] L. E. Kinsler, A. R. Frey, A. B. Coppens, and J. V. Sanders, -" Fundamentals of Acoustics," 3rd ed., Wiley, New York, (1982).

[30] L. Beranek, " Acoustics," American Institute of Physics, NewYork, (1986).

[31] Rossi, M., " Acoustics and Electroacoustics," Artech house, -Norwood, MA, pp.245-373,(1988).

[32] Walter D. Pilkey, " Formulas for Stress, Strain, and Structural -Matrices," John Wiley & Sons, Inc, New York, pp.1058-1059,(1994).