Research on FPGA-based Device For Detecting the Contact of Small End Bushings on Engine Connecting Rod

Guan Wang[1,2], **Zebin Su[1,2]**, Tong Li[1,2]

[1]*School of Electromechanical Engineering Guangdong University of Technology, Guangzhou 510006, China*

[2]*Guangdong Provincial Key Laboratory of Advanced Manufacturing Technology for Marine Energy Equipment, Guangzhou 510006, China*

qq625352162@gmail.com

Abstract The bushing in the connecting rod is an important component in the engine, connecting the small end of the connecting rod with the piston pin. During engine operation, if the contact degrees of the bushing and the small end hole is poor, it may lead to relative rotation or detachment of the liner, potentially resulting in safety accidents in severe cases. As an important detection method in the non-destructive testing field, ultrasonic inspection has been widely applied in industrial production. It is characterized by high reliability, fast detection speed, and wide detection range. Therefore, this paper proposes the design of an ultrasonic testing device for detecting the contact degrees of the small end of the connecting rod. In this paper, Simulate and design ultrasonic transmission circuit, reception circuit, and front-end analog signal processing circuit to achieve automatic gain amplification and reception of echo signals. Design a direct digital synthesis (DDS) signal generator and high-speed signal acquisition system based on FPGA. Utilize the DDS signal generator to generate pulse width modulation (PWM) signals as the signal source for the ultrasonic transmission circuit, controll the pulse frequency generated by the ultrasonic transmission circuit. The high-speed signal acquisition system transmits the collected signals to the host computer via a serial port. The upper computer processes and synthesizes the collected echo signals to realize ultrasonic A-scan, B-scan, and C-scan. Due to B-scan and C-scan data are image signals, labelling them are difficult, the equipment built is used to collect ultrasonic A-scan data for the connecting rod and construct a dataset of the contact conditions of the connecting rod small end hole bushings. Build a classification model for connecting rod bushing contact degrees conditions based on the XGBoost model, which can achieve the a classification accuracy up to 100%.

Keywords *Small end of* connecting rod; Contact degrees detection; FPGA; XGBoost

Reference

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