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基于FPGA的多路无串扰超声测距系统的设计与实现

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摘　要：

本文给出了一种基于现场可编程门阵列（FPGA）的多路无串扰超声测距系统的设计与实施方案。在前期设计的超声收发一体的硬件电路基础上，本文采用FPGA作为整个测距系统的核心，用于控制编码超声序列的收发及实现基于相关算法的测距。系统中采用有限状态机设计思想，充分利用FPGA中存储器资源。基于前期对不同种类的编码与调制组合性能的评估，本文选择了Gold序列结合二值频移键控调制方式激励超声换能器。为降低回声相关计算的复杂度和减少FPGA内资源占用，采用二值极化相关的方法处理回声信号以捕获渡越时间。实验测试结果表明，该测距系统在35厘米到420厘米的范围内可实现10毫米的测距精度，并可有效消除超声串扰。

关键词：超声测距；超声串扰；扩频；编码；过零极化相关；渡越时间；现场可编程门阵列

Design and implementation of FPGA-based multi-channel non-crosstalk sonar system

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Abstract:

This paper presents the design and implementation of a field programmable gate array (FPGA) based multi-channel non-crosstalk sonar system. Based on the early designed hardware circuits of ultrasonic transceivers, a FPGA chip is used to control the transmission and receiving of the code-modulation sequences as well as to achieve the correlation based distance measurement. Finite state machine is applied to make full use of most of the FPGA’s storage. Gold sequence combined with binary frequency shift keying (BFSK) modulation is chosen as the excitation sequence after assessing the performances of different codes and modulations’ combinations. To reduce the complexity of echo correlation and the usage of FPGA’s storage, the binary polarity correlation is adopted to process the echo signal for capturing the time of flight. Experiments’ results show that this sonar system achieves an accuracy of 10 mm in the range between 35 cm and 420 cm without crosstalk.

Keywords: ultrasonic ranging; ultrasonic crosstalk; spread spectrum; coding; cross-zero polarity correlation; time-of-flight; FPGA

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