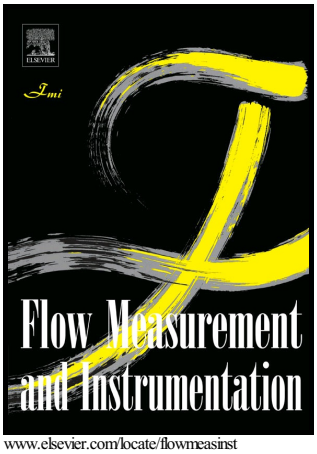

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Abstract

Accurate determination of time-of-flight (TOF) is crucially important for precise ultrasonic flow measurement. Detection of ultrasonic signal onset (USO) is considered as an effective approach to determine the actual value of TOF. The USO can be estimated by signal fitting methods. However, the estimation accuracy and reliability of existing methods still need to be improved. This paper proposes a signal fitting method based on artificial fish swarm algorithm and particle swarm optimization combined algorithm (AFSA-PSO). In the method, AFSA is introduced to search all possible solution spaces firstly, considering the multi-modal characteristic of the objective function in signal fitting which is easily being amplified by the strong noise. Then, a feasible solution extraction strategy is proposed to extract the local optimal solution in every space. Finally, PSO is employed to further process the local solutions to obtain the accurate USO. The method is validated by both numerical and experiment tests, using simulated signals with different strength noise and measured signal in actual ultrasonic flowmeter respectively. Comparisons with the methods proposed by other researchers are also given in the paper. The proposed AFSA-PSO is found to be more accurate, more robust, having better anti-noise ability and less time-consuming under a given accuracy requirement.

***Keywords*-ultrasonic flowmeter, signal onset, time-of-flight, artificial fish swarm algorithm, feasible solution extraction, particle swarm optimization.**

1. Introduction

For ultrasonic flow measurement based on time difference principle, accurate determination of time-of-flight (TOF) is crucially important. Traditional methods commonly detect the time positions of zero-crossing points on the received signal at the cycles having enough large amplitude to determine