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# A new signal processing algorithm of pulsed infrared thermography

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**Abstract:** A new signal processing algorithm combining Markov and principal component analysis (PCA) algorithm, which was named as Markov-PCA algorithm, was proposed to process the pulsed infrared thermography. First, the image sequence was reconstructed using Markov algorithm, then the original complex data dimensionality was reduced using PCA algorithm, which can remove the noise and redundancy of the infrared image sequences, and thus improve the detectability of defects. Results show that both the starting frame position and size of analysis window has an obvious effect on the processing results of Markov-PCA algorithm. And the proposed Markov-PCA algorithm improves the signal to noise ratio (SNR) of feature images more significantly than the commonly used PPT algorithm.

**Keywords:** Image sequence, Markov, Principal component analysis, SNR.

## 1. Introduction

In the last years, infrared thermography is a new non-destructive inspection technique which have being applied in more and more engineering projects [1-2]. As the existence of uneven heating, environmental noise and other limitations of pulsed infrared thermography, kinds of signal processing algorithms to improve the SNR of images were studied by many scholars. X.Maldague [3-4] of Canada Lavel University first proposed pulsed phase thermography (PPT), with the combination of optical pulsed thermography and lock-in thermography method, using the former incentive method combined with the latter signal processing method to overcome the limitations of heating uniformity of the former and long signal processing time of the latter. M.Genest [5] of Canada National Research Council combined background subtraction and PPT method, while detecting deboned defects of composite materials, which improved the SNR of images effectively. Brazil scholar Fernando Lopez [6] used pulsed infrared thermography method to detect deboned defects of carbon fiber reinforced composites, and made comparison of the thermo graphic sequence reconstruction (TSR), differential and absolute value of contrast (DAC), and PPT. The results show that TSR and DAC methods will be limited by the depth of defects and sampling time, while PPT treatment effect is relatively good, but is influenced by the high frequency oscillation.

In the pulsed infrared image sequences, when the temperature state of arbitrary pixel at time $N$ is known, the probability of its state at time $N+1$ can be determined by that of time $N$, so the process can be regarded as Markov process whose state and time parameters are discrete. In this paper, a new signal processing algorithm combining Markov and principal component analysis

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