萤火虫算法优化的小波域图像水印技术

王世辉，王仪明，武淑琴，田贝
(北京印刷学院 数字化印刷装备北京市重点实验室，北京 102600)

摘要： 针对水印不可感知性和鲁棒性难均衡的问题，提取一种萤火虫算法优化的小波域图像水印新方法.首先对原始载体图像进行 2 级 Haar 离散小波变换（DWT），分别对得到的第 2 级逼近子图 LL2、垂直细节子图 LH2、水平细节子图 HL2 运行奇异值分解（SVD），作为水印嵌入位置.然后对水印图像进行 Arnold 置乱加密和 1 级 Haar DWT，分别对得到的逼近子图 LL1、垂直细节子图 LH1、水平细节子图 HL1 运行 SVD，作为待嵌入信息.最后采用萤火虫算法（FA）得到水印嵌入的最优强度因子.实验表明，此算法可较好均衡图像水印的不可感知性和鲁棒性.

关键词： 图像水印；萤火虫算法；离散小波变换；鲁棒性；不可感知性

A Watermarking Method in Wavelet Domain Optimized by Firefly Algorithm

WANG Shi-hui，WANG Yi-ming，WU Shu-qin，TIAN Bei
(Beijing Key Laboratory of Digital Printing Machinery, Beijing Institute of Graphic Communication, Beijing 102600,China)

Abstract： A new method of image watermarking in wavelet domain optimized by Firefly Algorithm is proposed to solve the problem that it is difficult to balance imperceptibility and robustness in watermarking. Firstly, the two layer Haar discrete wavelet transform（DWT） is applied on original host image, then singular value decomposition (SVD) is applied to the obtained second-level approximation subgraph LL2, vertical detail subgraph LH2 and horizontal detail subgraph HL2,which are taken as the watermark embedding position. Then, the watermarking image is processed by Arnold transform and one layer Haar DWT. The SVD is applied to the obtained approximation subgraph LL1, vertical detail subgraph LH1 and horizontal detail subgraph HL1,which are taken as the information to be embedded. Finally, the optimal intensity factor of watermarking embedding is obtained by using Firefly Algorithm（FA）.The experimental results show that the proposed algorithm can well balance the imperceptibility and robustness of the image watermarking.

Key words：image watermarking；Firefly Algorithm；discrete wavelet transform；robustness；imperceptibility

作者简介：
王世辉男，（1992-），硕士研究生.研究方向为图像处理技术.E-mail:shw2011zc@163.com.
王仪明男，（1965-），博士，教授，博士生导师.研究方向为印刷机械检测与故障诊断技术.
武淑琴女，（1973-），硕士，副教授.研究方向为印刷机械检测与故障诊断技术.
田贝女，（1992-），硕士研究生.研究方向为 VOCs 处理技术.