论文类型：会议论文

拟投期刊：Optoelectronic Imaging and Multimedia Technology VIII

相关项目信息：无

论文录用通知: 见图片 “录用通知.jpg” （会议后出版，出版信息暂无）

论文附件信息：无 （会议论文暂时只投摘要）

论文题目：Denoising of event-based sensors with deep neural networks

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关键词：事件相机，去噪，深度网络

英文关键词：event camera; denoising; deep neural network

摘要：

事件相机是一类基于神经形态视觉的新型异步成像传感器。该传感器受人类视网膜的启发，只对亮度变化区域敏感，并以特殊的地址-事件-表示(address-event-representation, AER)形式输出包含位置、时间和极性变化信息的事件序列。与传统摄像机相比，事件摄像机具有功耗低、时间延迟小、动态范围大等优点，在自动驾驶、高速目标检测与跟踪等方面具有很大的应用潜力。然而，原始事件序列的低信噪比严重限制了事件摄像机在实际场景中的性能。此外，由于事件相机的图像数据形式的特殊性，传统的基于帧的图像去噪方法不适用于事件相机的去噪。近年来，基于深度学习的方法在许多视觉任务中得到了广泛的应用，并取得了巨大的成功。为了弥合基于事件传感器与真实场景应用之间的鸿沟，我们提出了两种基于深度神经网络的基于事件传感器去噪方法，即卷积去噪自编码器(ConvDAE)和序列切分循环神经网络(SeqRNN)。ConvDAE将事件序列转换为二维图像，然后使用自动编码器去噪，这使得它能够兼容现有的深度去噪和高级视觉任务。SeqRNN利用递归神经网络处理长时间序列的优势，在保持事件原始AER表示形式的同时实现在线去噪。我们在不同的数据集上进行了仿真和真实实验，仿真和真实数据实验均表明，所提出的方法能够成功地完成事件摄像机的去噪任务，满足相应场景下的应用要求。

英文摘要：

The event-based sensor is a novel class of asynchronous imaging sensor based on neuromorphic vision. Inspired by human being’s retina, the sensor is only sensitive to the region with brightness changes and outputs event sequences containing information of changing positions, time and polarities in a special form named address-event-representation (AER). Compared with traditional cameras, event cameras have many advantages, such as low power consumption, low temporal latency and large dynamic range, which provide them with great potential applications in auto-driving, high-speed target detection and tracking and so on. However, the low signal to noise ratio (SNR) of original event sequences seriously limits event cameras’ performance in actual scenarios. Besides, due to event camera’s special data form of AER, traditional frame-based image denoising methods are unsuitable for event camera’s denoising. In recent years, deep learning based approaches have been wildly used in many visual tasks and achieve great success. To bridge the gap between event-based sensors and real scenario applications, we proposed two deep neural network based denoising methods for event-based sensors, i.e., Convolutional Denoising Auto-Encoder (ConvDAE) and Sequence segmentation Recurrent Neural Network (SeqRNN). ConvDAE converts the event sequence into 2D images and then involves an auto-encoder for denoising, which makes it compatible with existing deep denoisers and high-level vision tasks. SeqRNN utilizes recurrent neural network’s advantages in dealing with low-term temporal sequence to realize online denoising while keep the event’s original AER representation form. We carry out simulated and real experiments on different datasets, and both simulation and real data experiments demonstrate that proposed methods can successfully complete the denoising task of the event camera, and meet the application requirements in corresponding scenarios.