Live Demonstration: A Real-Time Moving Object Localization and Extraction System

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***Abstract*—We demonstrate a real-time moving object localization and extraction system. The system consists of a 256 × 256 CMOS image sensor and an Opal-Kelly FPGA board. Frame differencing is utilized for motion detection; a stream of binary motion events are generated and further fed to a clustering-based object localization unit, where each event is processed on the fly. At the end of one frame, the moving object region is immediately localized and an image of that region is extracted.**

I. Introduction

Fast-motion object detection and localization is important to a number of applications such as surveillance, security monitoring and road traffic enforcement. These applications require continuous image acquisition and processing in real time. In addition, some systems also require multiple sensors (e.g. wireless sensor network) to cover a large surveillance area and different view angles. To alleviate the data transfer pressure of wireless channels, raw image data have to be locally processed in real time to obtain features of interest.

With the above considerations in mind, we designed a real-time object localization and extraction system. The system consists of a 256 × 256 CMOS image sensor and an Opal-Kelly FPGA board. We use frame difference for background subtraction, which will generate a stream of binary motion events. These events are then processed on the fly by clustering-based object localization circuits. At the end of one frame, the bounding box of the largest object in the scene is obtained immediately, and an image of that region is extracted.

Fig. 1 demonstrates the intermediate clusters' status during the on-the-fly clustering process. The scene contains a main moving object (human body) and noisy background (small objects). The algorithm clusters each event based on a distance criterion. It can merge small clusters instantly if they grow and get close to each other. A cluster discarding strategy is also adopted to remove noisy clusters and reduce hardware resources cost. At the end of one frame, the largest cluster is considered as the main moving object in the scene. The region of interest is easily obtained and extracted. For details of the algorithm and its hardware implementation, please refer to [1].

II. Demonstration Setup

The equipment of the demo system (Fig. 2) includes a laptop PC and a 256 × 256 image sensor, which is mounted on a PCB board and attached to an credit-card-sized Opal-Kelly XEM 3010 FPGA board. The FPGA receives image data from the sensor, localizes the main moving object and reports the analog image of region of interest (ROI) to the laptop PC.

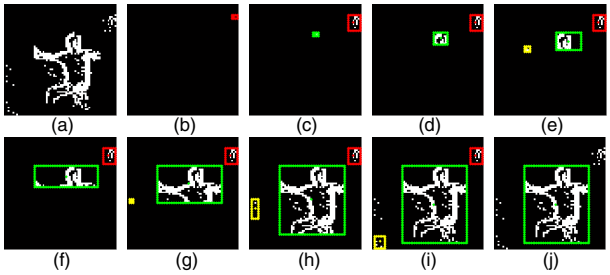

Fig. 1. Evolution of the intermediate clusters during the sequential scanning of a temporal difference image. The binary motion events are processed on the fly by 3 clusters. Two clusters can be merged if they grow and get close to each other. Noisy clusters will be discarded. At the end of one frame, the largest cluster contains the size and position information of the main object.

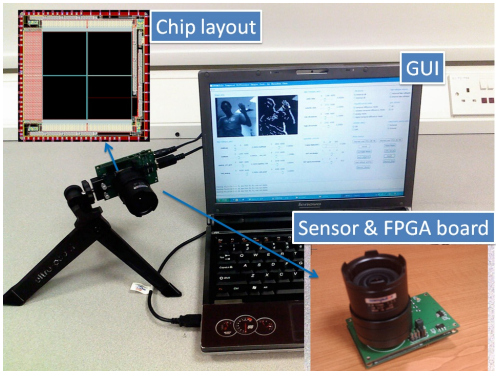

Fig. 2. Setup of the demo system

III. Visitors Experience

During the demo, visitors may stand in front of the image sensor and make some movement. The GUI on computer will display in real time the raw image, motion image, localization result and the extracted ROI image. For instance, if the visitor puts a hand in front of the camera and moves, the display can track the movement and focus to the hand.

IV. Track Selection

This demo would be related to track 11.1: Imagers and Vision Processing.

References

[1] B. Zhao, X. Zhang, S. Chen, K.-S. Low and H. Zhuang, "A 64 × 64 CMOS image sensor with on-chip moving object detection and localization," *IEEE Transactions on Circuits and Systems for Video Technology*, doi: 10.1109/TCSVT.2011.2170119, URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6032080&isnumber=4358651, 2011.