Design and Implementation of Wireless Sensor Node for Public Safety Video Surveillance System

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Abstract: **A taxonomy of wireless visual sensor networks for surveillance offers design goals that try to balance the public safety and application performance requirements. Surveillance camera, a wireless smart camera network platform, tries to address the challenges raised by achieving public safety.Video cameras in public are a good idea because they deter people from committing crime.Having video surveillance cameras placed in public places is a good idea because people are less likely to commit crimes in the area if they know they're going to be being filmed the whole time.**

Key-words: Cameras, video surveillance, FPGA controller, wireless sensor networks.

I. INTRODUCTION

Surveillance cameras can be an effective technique to protect public safety and detect or deter criminal activity. Surveillance cameras are increasingly being installed inside and outside of public buildings (in elevators, hallways, entrances, etc.), on streets, highways, in parks and public transportation vehicles. Public bodies subject to the **Freedom of Information and Protection of Privacy Act (the FOIP Act)** must balance the benefits to the public against the rights of individuals to be left alone. A key issue in privacy protection is the regulation of the collection of personal information, thereby preventing unnecessary surveillance of individuals.They are also not intended to apply to workplace surveillance systems installed by a public body employer to conduct surveillance of employees.Other considerations may apply to this type of surveillance and will not be covered in this guide.FPGAs offer many performance benefits for executing image processing applications.

This paper is organized as follows:

- It describes system architecture and functions of each block.
- It covers the block diagram for FPGA.
- It analysis the goal of surveillance camera sensor node.
- It gives the concept of image processing.
- The experimental results are shown.
- Finally, a brief conclusions are given.

II. SECURITY WORK

Security is a major concern in WVSN design: wireless surveillancesystems must protect any data that could leak private information about objects and environments they track to those sniffing the communication medium or trying to break into either local data storage or remotestorage (at a server).Personal information using surveillance cameras any record of the image of an identifiable individual is a record of personal information. Since surveillance systems collect personal information about identifiable individuals, public bodies must determine if they have the authority to collect personal informationof the FOIP Act.

Under that section, no personal information may be collected by or for a public body unless the collection is expressly authorized by an enactment of Alberta or Canada;The information is collected for the purposes of law enforcement or the information relates directly to and is necessary for an operating program or activity of the public body.Public bodies must be able to demonstrate to the Information and Privacy Commissioner that any proposed or existing collection of personal information by surveillance cameras is authorized under one of the above sections of the Act.

Video surveillance allows you to monitor or record activity in and around an area for many different reasons. For example, parents might want to watch over a sleeping child and lessen the risk of a dangerous fall from the crib. But a security camera system around the house can see people who approach the front door and maybe even catch a criminal in the act of breaking inThere's a wide variety of security cameras available. Some are large and out in the open, and might serve simply to deter criminals from even approaching a home, while others are tiny and meant to stay hidden from view. If you're considering setting up some type of video surveillance system in or around your home, there are a lot of questions to ask yourself before getting started. To learn about the different types of security cameras out there and which systems are best for certain situations.

III. CAMERA NODE

Extra computational capabilities are required for camera sensor nodes. Memory sizes of tens or hundered Kilobytes are not suitable for image and video storage. Camera nodes are equipped with larger memory and sometimes they contain different types of memory such as SRAM and DRAM. The node should be equipped with a fast and high efficient processor. DSPs, FPGAs and advanced fast RISC processors are commonly used for this purposes. Leonardo .et al designed a people counting system based on camera sensor node equipped with ultra-power FPGA chip. The developed code has been integrated on the prototype of a WCN node that consumes as little as 5mW. Qin et al. reduced the required network bandwidth using image compression.

Fig 1: Surveillance Camera Node

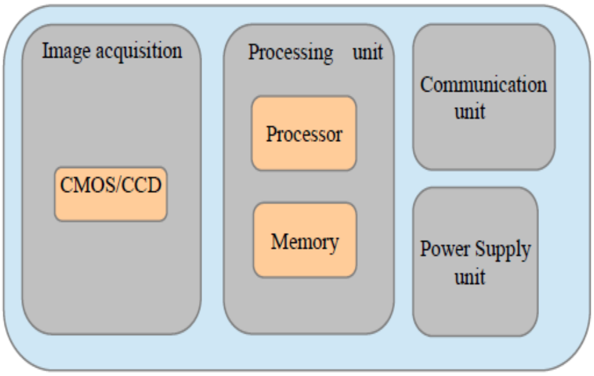

Fig 2: Surveillance Camera Node

IV. EXPERIMENTAL SETUP

Considering the experimental setup and challenge for public safety video surveillance camera deign,The Spartan-3A DSP FPGA Video Starter Kit is a tool designed to assist users in video processing applications. By utilizing an FPGA, parallel processing increases speed and performance of a system at minimal cost.

It can be categorized into three sectors:

- Spartan-3A DSP 3400A Development Platform.
- FMC-Video daughter card.
- VGA camera.

The FMC-Video daughter card is an optional component1 for the system which increases the videocapability of the Development Platform but is necessary in using the Xilinx provided demos thus will be used in this application note.This document contains basic information for setting up the system and information regardinghow to run the Xilinx provided demos. This document does not include instructions formodifying the demos or steps for a user to implement their own designs. Before connecting any components or installing any software, it is essential that the user reads this document thoroughly to prevent damage to the system.

The FPGA design can also reduce the system costs with various verification techniquessuch as behavioral simulation and post-route simulation. Moreover, Xilinx Embedded Development Kit (EDK) tools make it possible to implement a complete video processing system on a single FPGA using hardware/software codesign methods. The objective of this work is to develop a real-time edge detection system with an input from a CMOS camera and output to a DVI display and verified the results videoin real time.

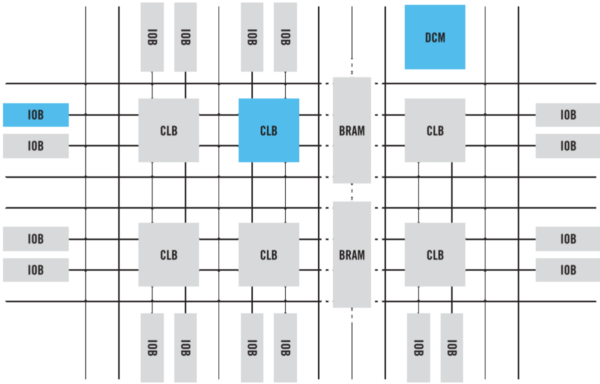

Fig 3: FPGA STRUCTURE

Field-programmable gate arrays (FPGAs) are reprogrammable silicon chips. Ross Freeman, the cofounder of Xilinx, invented the first FPGA in 1985. FPGA chip adoption across all industries is driven by the fact that FPGAs combine the best Parts of application-specific integrated circuits (ASICs) and Processorbased systems. FPGAs provide hardware-timed speed and reliability, but they do not require high volumes to justify the large upfront expense of custom ASIC design. A vague term for slower, non-volatile storage, usually magnetic disk, in contrast to main memory which is usually volatile semiconductor RAM.The Extended Spartan®-3A family of Field-Programmable Gate Arrays (FPGAs) solves the design challenges in many high-volume,cost-sensitive electronic applications. With 12 devices ranging from 50,000 to 3.4 million system gates.

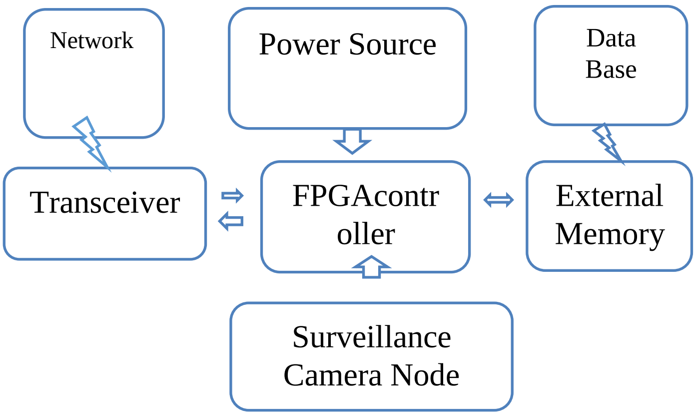

Fig 4: Block Diagram

V. DESIGN REQUIREMENTS

Wireless visual sensor network(WVSNs) have enabled surveillance applications in a variety of scenarios including environmental and habitat monitoring, emergency response and disaster rescue, law enforcement, and assisted living. Many camera platforms aim to meet strict hardware requirements for both indoor and outdoor wireless sensor network deployment. In the design of outdoor camera networks, power efficiency is a primary requirement. Another requirement is to intelligently distribute available bandwidth among all the network nodes, particularly in dense deployments.In addition to using efficient hardware, a WVSN must satisfy demanding performance requirements while employing energy-efficient strategies to maximize its life. The surveillance of public spaces requires not only efficientresource use to maximize service availability and life, but also mechanisms to ensure that data collection and handling does not compromise an individual's privacy.

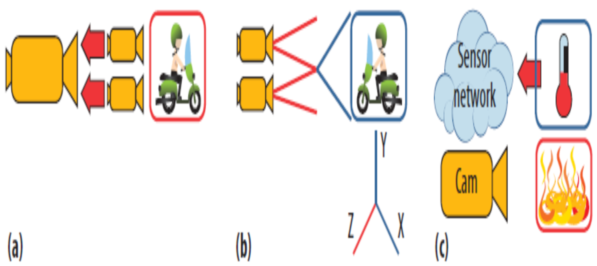

Fig 5: wireless visual sensor network (WVSN) designs. (a) A multitier network uses two camera types to offload the computational burden. Other networks (b) use cameras with overlapping fields of view to better evaluate an object's activity in 3D space and (c) rely on multimodal sensors to refine the evaluation of a situation, using both images of a fire and temperature data, for example.

Another hard requirement is to store and transmit only relevant data to the user and thus avoid consuming unnecessary network resources and overwhelming the wireless device with massive amounts of useless information.Visual sensor data has far higher storage and bandwidth requirements than scalar sensor data. Having cameras always on to record live footage in outdoor surveillancescenarios is prohibitivelyexpensive. Instead, many solutionsemploy local processing—at the sensor nodes to greatly decrease the data that the network must transmitand archive. Whether the surveillance application's goal is to detect events or identify objects, local data processing can help prevent false alarms because it gives the camera enough information to discern if the movement is genuine.Allowing the surveillance systems to automate the analysis process reduces the need for a remote operator to be watching live video feeds at all times.

To analyze visual data locally and make adequate decisions, WVSNs have been exploiting computer vision's increasingly more refined techniques and algorithms the result of rapid progress in both computer vision and image processing research. This convergence of algorithmic sophistication and high-quality cameras with better processing and storage capabilities is boosting the visual analytics capabilities of individual sensor nodes, which inturn is making local processing more technically feasible and affordable.In most wireless sensor networks, power efficiency is a fundamental design requirement since nodes are typically battery powered and thus have no access to a continuous power source. For WVSNs, power efficiency /is an evengreater concern: cameras usually consume more power than other types of sensors.

5.IMAGE PROCESSING

When the system is initialized, the object detection module keeps taking pictures with 1,280 × 720resolution and resizes them to 426 × 240 for processing. The image processing module uses MoG to extract the foreground10at an average 3 fps. From the foreground, the module finds the contours and applies a bounded box that follows the contours' limit. To remove noise and false detection, processing incorporates a step to ignore objects below a configurable value's specific size.

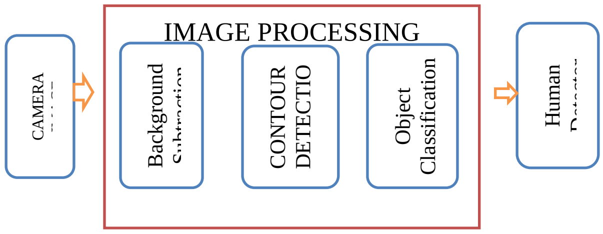

Fig 6. Image Processing Node

TABLE 1. Two Frame Differences (RGB)

Image Size	Time	Memory Requirements
640 * 480	50 ms	1.8 MB
320 * 240	19 ms	456 KB
160 * 120	9 ms	114 KB
Hierarchical	32 ms	1.8 MB

VI. SYSTEM ARCHITECTURE

The setup for implementation consists of the Spartan-3A DSP FPGA Video Starter Kit (VSK), a development platform consisting of the Spartan-3A DSP 3400A FPGA,the FMC-Video daughter card, and a VGA camera. The Spartan-3A DSP 3400A Development Platform is built around a Spartan-3A DSP XC3SD3400A device that provides significant resources for implementing high performance video processing systems and co-processors.The VSK includes a VGA camera based upon the Micron MT9V022 image sensor of resolution 720 x 480 pixels delivering serial frames at 60 fps through a FPGA Mezzanine Card (FMC) Daughter card which is an add-on card that augments the video capabilities ofthe Spartan-3A DSP 3400A Development Platform.The video processing application is designed as a system on a programmable chipwith the help of Embedded Design Kit. The serial video is de-serialized on the FMCVideo card. The resulting parallel data stream is the input to the Camera Inblock.

Fig.7 Spartan-3A DSP 3400 DevelopmentPlatform, FMC-Video, and Camera

The Camera PCORE registers the signals, and groups the video signals into a unified bus that is connected to the Camera Processing block, which is included in the camera frame buffer reference designs shipped with the VSK to control brightness, contrast and other Parameters. The edge filter is applied on the input signal arriving from the Camera Processing block. The output signal is Gamma corrected for the output DVI monitor and is driven by Display controller to the DVI output monitor. The Video to VFBC core manages the storing of video into frame buffers in external memory. It writes the video data to the VFBC interface on the MPMC memory controller.

VII. CONCLUSION

If the public body intends to significantly modify or expand the surveillance system, consult with the Office of the Information and Privacy Commissioner. TheCommissioner may conduct a site visit to assess the impact of the proposed modification.The camera based wireless sensor network supplies rich information about public safety applications. The data transmission rate of camera sensor nodes can be dramatically reduced by applying image analysis and processing at the sensor node side. Hierarchical structures for representing images are used to reduce both of required memory and computational complexity for motion detection Algorithms, which make it feasible to run these algorithms in tiny sensor nodes. Events detection supply us with a meaningful description of the raw video data, which reduces the human required works and efforts.

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