ENERGY EFFICIENT IMAGE TRANSMISSION IN WIRELESS SENSOR NETWORK USING RF CAMERA

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Abstract: The key obstacle to communicating images over wireless sensor networks has been the lack of suitable processing Architecture and communication strategies to deal with the large volume of data. High packet error rates and the need for retransmission make it inefficient in terms of energy and bandwith. This paper presents novel architecture and protocol for energy efficient image processing and communication over wireless sensor networks. Practical results show the effectiveness of these approaches to make image communication over wireless sensor networks feasible, reliable and efficient.

Key words: ZigBee, CMOS, PIR, LPC 2148

I. INTRODUCTION

In Wireless Multimedia Sensor Networks (WMSN), with the large volume of the multimedia data generated by the sensor nodes, both processing and transmission of data leads to higher levels of energy consumption than in any other types of wireless sensor networks (WSN). This requires the development of energy aware multimedia processing algorithms and energy efficient communication [1] in order to maximize network lifetime while meeting the QoS constraints.

A few protocols have been proposed to achieve image transmission over WSN [2]–[4]. Reference [2] aims at providing a reliable, synchronous transport protocol (RSTP), with connection termination similar to TCP, but does not consider the resource limitations of WSN. Reference [3] presents an energy-efficient and reliable transport protocol (ERTP) with hop-by-hop reliability control, which adjusts the maximum number of retransmission of a packet. Reference [4] proposes another reliable asynchronous image transfer (RAIT) protocol. It applies a double sliding window method, whereby network layer packets are checked and stored in a queue, to prevent packet loss. With protocols providing reliability at the transport [3] or network layers [4], erroneous packets at the application layer can still be forwarded to the base station, requiring retransmission and associated energy cost [5]. In [6], the authors stated that multi-hop transmission of JPEG2000 images is not feasible due to interference and packet loss. This statement is also cited by other literature [5], [7]. In this paper, image transmission over multi-hop WSN is proved to be feasible, using a combination of energy efficient processing architecture and a reliable application layer protocol that reduces packet error rate and retransmissions. A novel FPGA architecture is used to extract updated objects from the background image. Only the updated objects are transmitted using the proposed protocol, providing energy-efficient image transmission in error-prone environments.

II. ARCHITECTURE FOR OBJECT EXTRACTION

Fig. 1 presents the architecture of the proposed WMSN processing system. The network processor performs some standard operations as well as customized instructions to support the operations of the wireless transceiver. It operates at a low clock frequency to keep the power consumption low. The image processing block runs at a high frequency to process images at a high speed. By default, it is in inactive mode (sleep mode with suppressed clock source), and can be quickly set into the active mode by the network processor whenever an object extraction task needs to be performed.

In WMSN applications, the camera mote often has a fixed frame of view. In this case, to detect moving (updated) objects, background subtraction is a commonly used approach [8]. The basic concept of this is to detect the objects from the difference between the current frame and the background image. The background image represents a static scene of the camera view without any moving objects. An algorithm must be applied to keep the background image regularly updated to adapt to the changes in the camera view. For background subtraction, the Running Gaussian Average appears to have the fastest processing speed and lowest memory requirements [9]. It is further optimized for FPGA implementation and is incorporated into the proposed WMSN system.
A. Background Subtraction
The Running Gaussian Average model [8] is based on ideally fitting a Gaussian probability density function on the last n values of a pixel. The background pixel value at frame n is updated by the running average calculation shown in (1).

\[ B_n = (1 - \alpha) B_{n-1} + \alpha F_n \]

B. Object Extraction
An efficient object extraction algorithm has been implemented to detect portions of the current frame that is significantly different from the background image. It involves row and column scanning of the update signals (U) to determine if the number of consecutive differences (1s) is greater than a predetermined difference threshold. The proposed object extraction scheme, consisting of background subtraction, row/column scanning and threshold comparison blocks, was implemented and tested on various FPGAs. Table I compares the proposed architecture with [10] and [11], which have reported synthesis results for similar object extraction functions. Both [10] and [11] have used Altera FPGAs to synthesis their architectures. Hence, for a fair comparison, Table I reports synthesis results of the proposed architecture for the same Altera FPGAs. Clearly, the proposed architecture requires significantly less FPGA resources (LE – logic elements) compared with [10] and [11]. It has a maximum frequency of operation (Fmax) of 125.4MHz on Altera Cyclone III, the highest reported so far, due to its multiplier free and optimized hardware architecture.

III. THE HARDWARE SYSTEM
Micro controller: This section forms the control unit of the whole project. This section basically consists of a Microcontroller with its associated circuitry like Crystal with capacitors, Reset circuitry, Pull up resistors (if needed) and so on. The Microcontroller forms the heart of the project because it controls the devices being interfaced and communicates with the devices according to the program being written.

ARM7TDMI: ARM is the abbreviation of Advanced RISC Machines, it is the name of a class of processors, and is the name of a kind technology too. The RISC instruction set, and related decode mechanism are much simpler than those of Complex Instruction Set Computer(CISC) designs.

Liquid-crystal display (LCD) is a flat panel display, electronic visual display that uses the light modulation properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

IV. Design of Proposed Hardware System

![Block diagram](image)
The design of the entire system consisted of two parts, which are hardware and software. The hardware is designed by the rules of embedded systems, and the steps of software consisted of three parts. The existing method by improving the security level by implantation of ETHERNET that will solve this problem. WIFI based wireless technology which consists of transmitter at the site location and receiver at control panel. Information received at the receiver will be sent to the ETHERNET. So, the people living at home with internet connection can see the received data. The system uses a compact circuitry built around LPC2148 (ARM7) microcontroller Programs are developed in Embedded C. Flash magic is used for loading programs into Microcontroller.

V. Board Hardware Resources Features

CMOS CAMERA

Wireless technology is being applied to just about everything these days, and video surveillance takes good advantage of it. A wireless camera includes a built-in transmitter to send video over the air to a receiver instead of through a wire. Many people aren’t aware that there are multiple types of wireless technology in use, each with unique advantages and disadvantages.

Most wireless cameras are technically cordless devices, meaning that though they transmit a radio signal, they still need to be plugged into a power source. Still, “wireless” is the commonly used industry term. Some cameras do have batteries, of course, making them truly wireless. But battery life is still an issue for professional or even semi-professional applications.

These devices work on a simple principle. The camera contains a wireless radio (RF) transmitter. This transmitter broadcasts the camera’s video, which can be picked up by a receiver, which will be connected to a monitor or recording device. Some receivers have built-in storage, while others must be connected to a DVR.

Zigbee

Zigbee modules feature a UART interface, which allows any microcontroller or microprocessor to immediately use the services of the Zigbee protocol. All a Zigbee hardware designer has to do in this case is ensure that the host’s serial port logic levels are compatible with the XBee’s 2.8- to 3.4-V logic levels. The logic level conversion can be performed using either a standard RS-232 IC or logic level translators such as the 74LVTH125 when the host is directly connected to the XBee UART. The below table gives the pin description of transceiver. Data is presented to the X-Bee module through its DIN pin, and it must be in the asynchronous serial format, which consists of a start bit, 8 data bits, and a stop bit. Because the input data goes directly into the input of a UART within the X-Bee module, no bit inversions are necessary within the asynchronous serial data stream. All of the required timing and parity checking is automatically taken care of by the X-Bee’s UART

Pir sensor

An individual PIR sensor detects changes in the amount of infrared radiation impinging upon it, which varies depending on the temperature and surface characteristics of the objects in front of
the sensor. When an object, such as a human, passes in front of the background, such as a wall, the temperature at that point in the sensor's field of view will rise from room temperature to body temperature, and then back again. The sensor converts the resulting change in the incoming infrared radiation into a change in the output voltage, and this triggers the detection. Objects of similar temperature but different surface characteristics may also have a different infrared emission pattern, and thus moving them with respect to the background may trigger the detector as well.

VI. REFERENCES


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