International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

IJIEMR Transactions, online available on 18th Feb 2022. Link :http://www.ijiemr.org/downloads.php?vol=Volume-12&issue=Issue 02

DOI: 10.48047/IJIEMR/V12/ISSUE 02/51

Title **Design and Implementation of FPGA Based Smart Embedded Vision System for Biomedical Applications**

Volume 12, ISSUE 02, Pages: 332-336

Paper Authors
Y.Amar Babu, S.V.K.Pratap Reddy, N.Banbhushan, P.Venkatesh, K.Tirumala Krishna

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

Design and Implementation of FPGA Based Smart Embedded Vision System for Biomedical Applications

1st Y.Amar Babu, 2nd S.V.K.Pratap Reddy, 3rd N.Banbhushan, 4th P.Venkatesh, 5th K.Tirumala Krishna
Electronics and Communication Engineering, LBRCE COLLEGE, MYLAVARAM

Abstract
In today's smart world, applications in sectors like robotics, intelligent systems, and cars must have embedded vision with the best design metrics.A tiny vision system can be designed for the particular application using a miniature PC and camera; this type of system is known as an embedded vision system. This project suggests creating an embedded vision system and implementing it for real-time applications for improved design metrics .Low cost, quick development, small area, and fast speed are optimized design metrics.The ZYNQ SOC is used to implement the suggested embedded vision system.In order to deliver high flexibility, high performance, scalability and low power, the ZYNQ SOC integrate the hardware programmability of an FPGA with the software programmability of a processor into a single device.By connecting the OV7670 camera to the zedboard, the embedded vision system was put into practise.The client-server design of the Zedboard allows for real-time data streaming to the PC through Ethernet. The hardware platform for the proposed embedded vision system designing with VHDL built-in IP cores in Vivado, C-language application software create in SDK, and Petalinuxon Ubuntu is the framework required for applications based on embedded vision systems. The proposed smart embedded vision system is used for bio medical applications.

Index Terms — SOC, Embedded vision system, Ethernet, OV7670 camera module.

Introduction

Numerous portable and embedded devices can now operate with visual capabilities thanks to significant Over the past 20 years, computer vision research has advanced steadily and significantly. advancements and low-cost computing power. Today's digital image processing (DIP) and digital signal processing (DSP) fields are both intriguing to work in. It has been obtainable for over 20 years and is generally utilised in applications where price and performance are crucial, such as the entertainment sector, Home Security healthcare systems, the automobiles. The widely used general purpose processors are frequently used to implement DIP systems (GPPs). Specialized DSPs and General Purpose Graphics Processing Units (GPGPU) have been used as a result of the growing demand for high-speed. However, practically all DSP- based consumer electronic devices place a premium on power dissipation, making high-speed, power-hungry GPPs less de- sirable.Even products with line power are frequently sensitive to power consumption, especially battery-powered products. Alternatives for DIP designers like the Field Programmable Gate Array(FPGA)for minimal power usage and hardware acceleration.

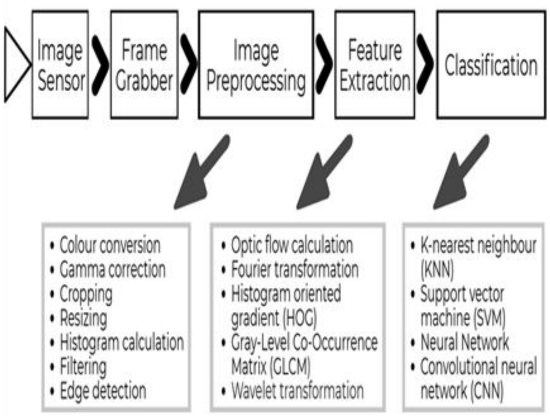

Fig. 1. Vision system pipeline.

Embedded Vision Systems

A. Central Processing Unit

Extensive use of image and vision applications in robotics, industrial automationsand monitoring necessitates the devel- opment of more effective real-time implementation methods. With the advent of several CPU-based platforms like the Beagle board and Raspberry-Pi.Real-time copyright protection hardware was prototyped using beagleboard-xM low-power open-source hardware by Hashmi et al[3]. On beagleboard- xM,, a human tracing system has been built that precisely recognises and tracks human movements. [4].[7] describes the implementation of an effective edge-detection algorithm for detecting activity range in an indoor setting using a Leopard Board. In a similar vein, Sharma and Kumar [8] proposed a picture-enhancing algorithmon a beagle board, mostly for tracking a person's health. Sahani and Mohanty [5] showed a number of computer based vision applications created on the Raspberry-Pi to prove the effectiveness of embedded image processing. The device employs a raspberry-pi-powered cam- era with resolution 1280x720 to instantaneously detect script and graphics.Other computer vision techniques have been put into practise utilising Raspberry-Pi on compact, specialised systems. [6] describes a robot that can handle light objects and has an on-board camera that processes camera data to help with navigation.Due to the portability and simplicity of programming, several robotic systemshave been implemented certain vision-based algorithms by using Raspberry-Pi.

B. Graphic Processing Unit

Numerous computer vision techniques can be accelerated thanks to the parallelism of GPUs [9]. GPGPU made avail- able on mobile devices in conjunction with newly developed heterogeneous programming models like OpenCL. Wang et al. [9] introduced an exemplar-based inpainting approach for object removal to investigate the potential of mobile GPU for the improving speed of computer based vision algorithms. Invariant to Scale Feature identification of transform fea- turestechnique was implemented by Rister et al. [10] uses a portable GPU to outperform a more condensed GPP imple- mentation in speed.With a reported speed-up of about 3.7, two GPU architectures are used to construct a face detection and identification system[11].Object detection using a mobile GPUtechnique is reported in [12], which is two times faster than a comparable implementation on a mobile GPP. As compared to a smartphone GPP, the energy is saved upto 84. Convolutional network scaling design for GPUs has been introduced in [13]. On an NVidia Kepler GPU, 50 replicas are used in a stochastic gradient distributed machine learning system to train the explored networks [13]. Because of its superior performance in object detection, deep learning, also known as Convolutional Neural Networks, has gained popu- larity in the disciplines of ML and computer based vision. A complicated CNN may take longer than a month to train with simply GPP . GPUs provide roughly ten times the speed-up over GPP, as shown in for quicker training and testing. Several further computer vision and images.The primary purpose of implementing processing algorithms on GPUs is to speed them for daily life requirements.

C. Field Programmable Gate Array

Many applications in different fields, including embedded vision and image processing, successfully employ FPGAs. Configurability is the main benefit of FPGA's over traditional CPUs or GPUs. While FPGA-based designs defer the ma- jority of these decisions to the application-oriented designer in order to optimise the utilisation of logic gates for a single application, GPPs' architecture requires that memory and resource allocation work effectively across a number of applications.As their nature permits massive amount of parallel, and pipelinexecution, they can also be substantially faster. FPGAs provide parallel processing of processing blocks that match the pipeline of a vision system shown in Figure and allow stream processing from camera inputThe self-organizing map variation reported in [2] and tested on two computers was created specifically for FPGA.Character recognition and appearance-based object identification are two computer vision

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

applications that are tested using a self-organizing map varia- tion created specifically for FPGA in [2].The Xilinx Virtex-4 XC4VLX160 was used for the implementation in [2] and is capable of training with about 25,000 patterns per second.

Design Methodology

Hardware Designing

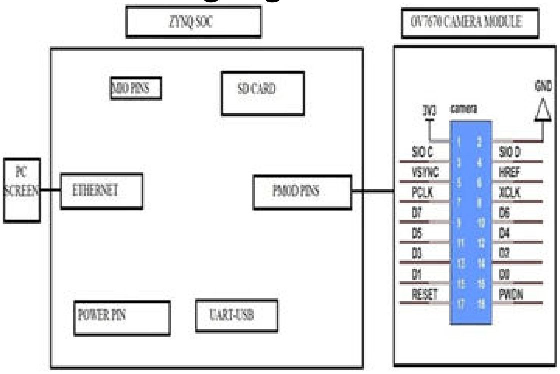

Fig. 2. Interface of Camera to Zedboard

The hardware platform for the proposed embedded vi- sion system is ZYNQ SOC. It contains processing system withARM cortex-A9 CPU with two cores and customizable logic using Artix-7. For embedded vision system can use one core of processing system. OV7670 camera interfaced to PMOD connections in PL of zedboard also made an Ethernet interface between pc and zedboard by connecting Ethernet cable through Ethernet port of zedboard. When zedboard turned on petalinux os on processing system boots first and then programmable logic will boot next. Then Real-time data captured by the OV7670 camera can transmit data to zedboard through Ethernet interface and processing of data by ARM cortex-A9. In this proposed design of embedded vision system it follows client-server architecture.

B. Design Flow

First and foremost, it is important to understand the spec- ifications needed to develop the suggested system. Zed- board (XC7Z020clg484-1), Vivado, Xilinx SDK, petalinux, an OV7670 camera module, and an Ethernet wire were the tools utilised in this design. creating an embedded vision system based on the ZYNQ SOC. Figure 3 depicts the design process in full.Vivado was used to design the hardware. this creates a bitstream that takes the form of (.bit file). After that, hardware will be exported, and a hardware description file (.hdf) will be made. In order to launch the SDK, the application project is created using the c or c++ programming language.After importing the design into the SDK and selecting the Linux operating system, the hardware platform, and the type of ap- plication, an application project will be built, and an executable and linkable file (.elf file) will be produced that can be used to create a bootimage for the chosen application. Because of its advantages and ease of access to new apps, petalinux is the ideal operating system for this application project.A modified version of the Linux operating system is called Petalinux OS. Ubuntu 16.04 was configured with Petalinux. Develop a

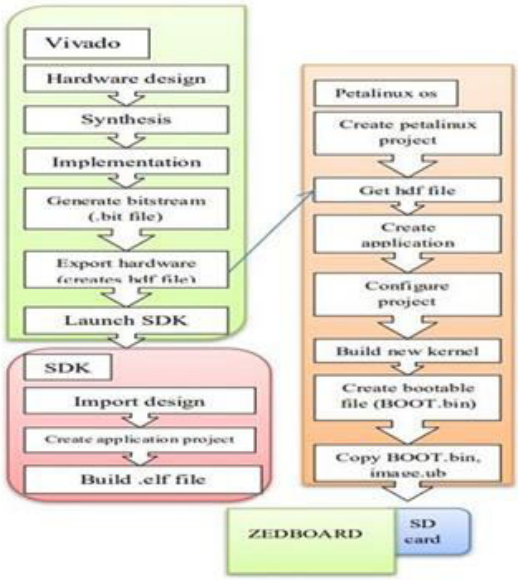

Fig. 3. Design flow

petalinux project in the petalinux operating system, download the vivado project's hardware description file, and then create a new application that works with the hardware designed. In the next step include the created application to the petalinux kernel and then build new

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

kernel after this images.ub is created and use .bit file, FSBL (first stage bootloader) elf file and .bit file to create bootable file. Bootable image is created and BOOT.bin and image.ub is copied into SDcard which in inserted to Zedboard. The main purpose of this project is to the data driven from OV7670 camera module which is interfaced to zedboard using TCP sockets and transferred to a client. Here in this design zedboard (XC7Z020clg484-1) running petalinux and python script is run by client. The server (zedboard) runs on petalinux which is written in c and is used to control the camera by taking snaps and sending those snaps to client (PC).

C. Implementation of Embedded Vision System for Medical Applications

- This Ingestible Capsule consists of Smart Embedded Vision System.
- The Smart Embedded Vision System can be used for identifying different problems in the human internal Or- gans.
- This Vision System can identify the intestine problems and it is useful for doing surgical operations.
- This project is with an intelligence which it has a thresh- hold level if the disease of a patient cross the threshhold value it intimate to the doctor.

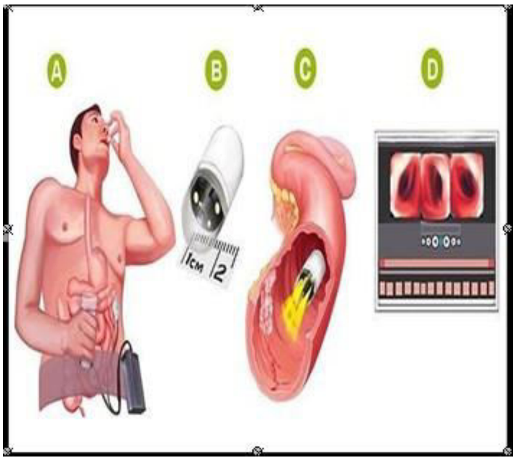

Fig. 4. Ingestible Capsule

Conclusion

Due to the widespread use of embedded systems, customer demand is also rising.We must be certain about the computing platform to be used while creating the vision system. The solution for this embedded system is based on general purpose processor(GPP), Reconfigurable devices (Field Programmable Gate Array). So we are using FPGA board for this system because of its properties like low power, high efficient and low cost. And reconfigurable blocks in board. By considering all the properties of FPGA board this is best computing platform.

References

[1] Design of Embedded Vision System based on FPGA-SoC Ahmed Alsheikhy1 , Yahia Fahem Said2 (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 10, No. 10, 2019.

[2] Appiah, K., Hunter, A., Dickinson, P., Meng, H.: Implementation and applications of tristate self-organizing maps on fpga. IEEE Transactions on Circuits and Systems for VideoTechnology 22(8), 1150–1160 (Aug 2012).

[3] Hashmi, M.F., Shukla, R.J., Keskar, A.G.: Platform independent real time copyright protection embedding and extraction algorithms on android and embedded framework. In: Int'l Symp. on Signal Processing and Info. Technology (ISSPIT). pp. 000189–000194 (2014).

[4] Gantala, A., Nehru, K., Telagam, N., Anjaneyulu, P., Swathi, D.: Human tracking system using beagle board - xm. Int'l Journal of Applied Engg. Research 12(16), 5665–5669 (2017).

[5] Sahani, M., Mohanty, M.N.: Realization of different algorithms using raspberry pi for realtime image processing application. In: Intelligent Computing, Communication and Devices,pp. 473–479. Springer (2015).

[6] Horak, K., Zalud, L.: Image processing on raspberry pi for mobile robotics. International Journal of Signal Processing Systems 4(2), 1–5 (2016).

[7] Appiah, K., Hunter, A., Lotfi, A., Waltham, C., Dickinson, P.: Human behavioural analysis with self-organizing map for ambient assisted living. In: 2014 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE). pp. 2430–2437 (July 2014).

[8] Sharma, G., Kumar, K.: Prototyping of image enhancement algorithms using beagle board for rural health monitoring. In: International Con- ference on Recent innovations in

Science, Management, Education and Technology. pp. 346–358 (August 2016).
[9] Wang, G., Xiong, Y., Yun, J., Cavallaro, J.R.: Accelerating computer vision algorithms using opencl framework on the mobile gpu - a case study. In: 2013 IEEE International Conference on Acoustics, Speech and Signal Processing. pp. 2629–2633 (May 2013).
[10] Rister, B., Wang, G., Wu, M., Cavallaro, J.R.: A fast and efficient sift detector using the mobile GPU. In: Proc. IEEE ICASSP. pp. 2674–2678 (2013).
[11] Yi, S., Yoon, I., Oh, C., Yi, Y.: Real-time integrated face detection and recognition on embedded gpgpus. In: 2014 IEEE 12th Symposium on Embedded Systems for Realtime Multimedia (ESTIMedia). pp. 98–107 (Oct 2014).
[12] Andargie, F.A., Rose, J., Austin, T., Bertacco, V.: Energy efficient object detection on the mobile gp-gpu. In: 2017 IEEE AFRICON. pp. 945–950 (Sept 2017).
[13] Szegedy, C., Vanhoucke, V., Ioffe, S., Shlens, J., Wojna, Z.: Rethinking the inception architecture for computer vision. In: The IEEE Conference on Computer Vision and Pattern Recognition (CVPR) (June 2016).
[14] Platform-Based Design Approach for Embedded Vision Applications Jai Gopal Pandey, Abhijit Karmakar, Chandra Shekhar Journal of Image and Graphics, Volume 1, No.1, March, 2019.
[15] FPGACam: A FPGA based efficient camera interfacing architecture for real time video processing Sayantam Sarkar1 — Satish S. Bhairannawar 2 — Raja K.B.3 19 March 2021 IET Circuits, Devices Systems
[16] https://www.gutworks.com.au/video-capsule-endoscopy-murdoch-perth/
[17] OV7670 CMOS Camera chip with Omni Pixel Technology Datasheet [online]: Available: https://www.voti.nl/docs/OV7670.pdf