

# FPGA design of a camera control system for road traffic monitoring

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**Abstract**—Video surveillance and monitoring more than a decade now remains a big challenge. Today is becoming more and more vital due to rapid development of hardware equipments as well as the software methods that support intelligent monitoring and analytics. This paper proposes the architecture of a FPGA design of a camera controller for surveillance that could be applied for road traffic monitoring and image data management purposes. The proposed system could deal with real-time monitoring of persistent and transient objects within the specific environment of a motorway or crossroad, taking input from a camera. Functional models were synthesized in VHDL. The design and simulations analysis were carried out within Quartus II Altera software package while further analysis was also performed with ModelSim. The functional performance and operation of the proposed design was evaluated based on such simulations and analysis.

**Keywords**—*monitoring; camera controller; FPGA design; simulations*

## I. INTRODUCTION

Video surveillance systems that use analog CCTV cameras and interfaces as the basis are not easily expandable, and have low video resolution with little or no signal processing. However, next generation of video surveillance systems with digital LAN cameras, that support complex image processing, and video-over-IP routing are more intelligent and allow further scalability and flexibility [6], [7], [8]. In this direction, programmable modules, with or without embedded DSP blocks, with memory blocks, several interfaces, and other units, fulfill the new contemporary system requirements [5], [12].

Today several systems are designed on the same chip, based on a Field Programmable Gate Array (FPGA), for intelligent and fast data processing and miniaturization of the system. Particularly, in modern surveillance systems, FPGA-based intelligent controllers play an important role in improving the performance of the camera control system [2], [3], [4], [16], [19].

The purpose of this paper is to present first results of an ongoing research project on the implementation of a smart camera control system for traffic surveillance based on a

FPGA. The problem of providing automated vision surveillance on an efficient way that last years has been intensively examined [10], [11], [13]. Today there is a rapid development of such systems towards intelligent control units [1], [9], [15] and several algorithms have been proposed towards this direction [14], [17].

In this research, the system proposed captures a video stream, computes traffic information and performs on chip video analytics and finally transfers the video stream and the traffic information to a host PC in order to be generated further alarm signals and events to be triggered according to various traffic situations. The objective of the paper is to describe the design of an intelligent surveillance system within an academic environment for traffic monitoring purposes. The proposed architecture incorporates a camera controller that obtains traffic images and performs analytics. It performs contour identification, axis specification, axis shift, percent zoom, smooth, etc., as well as facilities for mathematical and statistical analysis of the numerical data (pedestrians, cars, etc.), such as: densities, deviations, aggregates, etc.

In section II is described the design methodology followed and the goals aimed to be achieved. In section III the system architecture is detailed and section IV discusses the simulations carried towards the evaluation of system's functionality. Finally, section V presents a brief discussion and conclusions on the proposed system.

## II. DESIGN METHODOLOGY AND GOALS

### A. Design Approach

The overall design of the IP surveillance camera controller is to be implemented as a complete system on a chip using a FPGA device. An FPGA-based architecture is quite flexible and customizable, to such extend that easily allows a system architecture to be enhanced and modified according to various system specifications and requirements. Thus FPGA architectures are easily reconfigurable.

In addition, in our case study of remote traffic monitoring would be possible to add custom video processing software in real time (video analytics) and system upgrades (i.e. a new

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**Eighth International Conference on Road Traffic Monitoring and Control, 23-25 April 1996**, 1996 *Journal of Transportation and Statistics*, 2002 **Advanced Video-Based Surveillance Systems** Carlo S. Regazzoni, Gianni Fabri, Gianni Vernazza, 2012-12-06 Advanced Video Based Surveillance Systems presents second generation surveillance systems that automatically process large sets of signals for performance monitoring tasks Included is coverage of different architecture designs customization of surveillance architecture for end users advances in the processing of imaging sequences security systems sensors and remote monitoring projects Examples are provided of surveillance applications in highway traffic control subway stations wireless communications and other areas This work will be of interest to researchers in image processing computer vision digital signal processing and telecommunications Highway Maintenance Handbook Ken Atkinson, 1997-04-10 This handbook deals with the ongoing task of maintaining Britain's network of roads in a safe and satisfactory condition It provides a commentary on a range of maintenance areas and analyzes both concrete and bituminous carriageways highlighting the advantages or problems of each Intelligent Vehicle Technologies Ljubo Vlacic, Michel Parent, Fumio Harashima, 2001 Intelligent Vehicle Technologies covers the growing field of intelligent technologies from intelligent control systems to intelligent sensors Systems such as in car navigation devices and cruise control are already being introduced into modern vehicles but manufacturers are now racing to develop systems such as smart cruise control on vehicle driver information systems collision avoidance systems vision enhancement and roadworthiness diagnostics systems aimed specifically at the automotive industry packed with practical examples and applications in depth treatment written in a text book style rather than a theoretical specialist text style Sensors and Their Applications VIII, Proceedings of the eighth conference on Sensors and their Applications, held in Glasgow, UK, 7-10 September 1997 A. T. Augousti, Neil White, 1997-01-01 Sensors and Their Applications VIII provides a valuable forum for individuals from all over the world working in all areas of sensors to meet and discuss the developments and applications of transducers and sensor systems The strength of the sensor community in the UK reinforces the importance of this volume as a valuable reference for all workers in the field *Proceedings of the International Conference on Applications of Machine Intelligence and Data Analytics (ICAMIDA 2022)* Sharvari Tamane, Suddhasheel Ghosh, Sonal Deshmukh, 2023-05-01 This is an open access book As on date huge volumes of data are being generated through sensors satellites and simulators Modern research on data analytics and its applications reveal that several algorithms are being designed and developed to process these datasets either through the use of sequential and parallel processes In the current scenario of Industry 4.0 data analytics artificial intelligence and machine learning are being used to support decisions in space and time Further the availability of Graphical Processing Units GPUs and Tensor Processing Units TPUs have enabled to processing of these datasets Some of the applications of Artificial Intelligence Machine Learning and Data Analytics are in the domains of Agriculture Climate Change Disaster Prediction

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