

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 extent 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

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Electronic Systems and Intelligent Computing Pradeep Kumar Mallick, Preetisudha Meher, Alak Majumder, Santos Kumar Das, 2020-09-22 This book presents selected high quality research papers from the International Conference on Electronic Systems and Intelligent Computing ESIC 2020 held at NIT Yupia Arunachal Pradesh India on 24 March 2020 Discussing the latest challenges and solutions in the field of smart computing cyber physical systems and intelligent technologies it includes papers based on original theoretical practical and experimental simulations developments applications measurements and testing The applications and solutions featured provide valuable reference material for future product development

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of Transportation ,2021-05-13 In an increasingly globalised world despite reductions in costs and time transportation has become even more important as a facilitator of economic and human interaction this is reflected in technical advances in transportation systems increasing interest in how transportation interacts with society and the need to provide novel approaches to understanding its impacts This has become particularly acute with the impact that Covid 19 has had on transportation across the world at local national and international levels Encyclopedia of Transportation Seven Volume Set containing almost 600 articles brings a cross cutting and integrated approach to all aspects of transportation from a variety of interdisciplinary fields including engineering operations research economics geography and sociology in order to understand the changes taking place Emphasising the interaction between these different aspects of research it offers new solutions to modern day problems related to transportation Each of its nine sections is based around familiar themes but brings together the views of experts from different disciplinary perspectives Each section is edited by a subject expert who has commissioned articles from a range of authors representing different disciplines different parts of the world and different social perspectives The nine sections are structured around the following themes Transport Modes Freight Transport and Logistics Transport Safety and Security Transport Economics Traffic Management Transport Modelling and Data Management Transport Policy and Planning Transport Psychology Sustainability and Health Issues in Transportation Some articles provide a technical introduction to a topic whilst others provide a bridge between topics or a more future oriented view of new research areas or challenges The end result is a reference work that offers researchers and practitioners new approaches new ways of thinking and novel solutions to problems All encompassing and expertly authored this outstanding reference work will be essential reading for all students and researchers interested in transportation and its global impact in what is a very uncertain world Provides a forward looking and integrated approach to transportation Updated with future technological impacts such as self driving vehicles cyber physical systems and big data analytics Includes comprehensive coverage Presents a worldwide approach including sets of comparative studies and applications *Smart Cities, Green Technologies and Intelligent Transport Systems* Brian Donnellan,Cornel Klein,Markus Helfert,Oleg Gusikhin,2019-07-29 This book constitutes the thoroughly refereed post conference proceedings of the 7th International Conference on Smart Cities and Green ICT Systems SMARTGREENS 2018 and the 4th International Conference on Vehicle Technology and Intelligent Transport Systems VEHITS 2018 held in Funchal Madeira Portugal in March 2018 The 18 full papers presented during SMARTGREENS 2018 and VEHITS 2018 were carefully reviewed and selected from numerous submissions The papers reflect topics such as smart cities and green ICT systems vehicle technology and intelligent transport systems **Index of Conference Proceedings** British Library. Document Supply Centre,2002 **Applications and Innovations in Intelligent Systems VIII** Ann Macintosh,Mike Moulton,Frans Coenen,2012-12-06 Ann Macintosh Napier University UK The papers in this volume are the refereed application papers presented at ES2000 the Twentieth SGES International Conference

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IEEE International Conference on Intelligent Transportation Systems Proceedings, 2003 3rd EAI International Conference on Big Data Innovation for Sustainable Cognitive Computing Anandakumar Haldorai, Arulmurugan Ramu, Sudha Mohanram, Joan Lu, 2022-01-01

This book features the proceedings of The EAI International Conference on Big Data Innovation for Sustainable Cognitive Computing BDCC 2020 which took place 18 19 December 2020 The papers feature detail on cognitive computing and its self learning systems that use data mining pattern recognition and natural language processing NLP to mirror the way the human brain works This international conference focuses on technologies from knowledge representation techniques and natural language processing algorithms to dynamic learning approaches Topics covered include Data Science for Cognitive Analysis Real Time Ubiquitous Data Science Platform for Privacy Preserving Data Science and Internet Based Cognitive Platform

Challenges and Solutions for Sustainable Smart City Development R. Maheswar, M. Balasaraswathi, Ravi Rastogi, A. Sampathkumar, G. R. Kanagachidambaresan, 2021-05-22 This book discusses advances in smart and sustainable development of smart environments The authors discuss the challenges faced in developing sustainable smart applications and provide potential solutions The solutions are aimed at improving reliability and security with the goal of affordability safety and durability Topics include health care applications sustainable smart transportation systems intelligent sustainable wearable electronics and sustainable smart building and alert systems Authors are from both industry and academia and present research from around the world Addresses problems and solutions for sustainable development of smart cities Includes applications such as healthcare transportation wearables security and more Relevant for scientist and researchers working on real time smart city development *Big Data Analytics and Data Science* Vikrant Bhateja, Hong Lin, Milan Simic, Jinshan Tang, Vustikayala Sivakumar Reddy, 2024-12-23 This book presents a collection of high quality peer reviewed research papers

from the 8th International Conference on Information System Design and Intelligent Applications ISDIA 2024 held in Dubai UAE from 3 4 January 2024 It covers a wide range of topics in computer science and information technology including data mining and data warehousing high performance computing parallel and distributed computing computational intelligence soft computing big data cloud computing grid computing cognitive computing and information security Proceedings of the 15th International Conference on Soft Computing and Pattern Recognition (SoCPaR 2023) Anu Bajaj, Proceedings of the 8th International Conference on Construction, Architecture and Technosphere Safety Andrey A. Radionov,Dmitrii V. Ulrikh,Vadim R. Gasiyarov,2024-12-31 This book highlights recent findings in civil and environmental engineering and urban planning and provides an overview of the state of the art in these fields mainly in Russia and Eastern Europe A broad range of topics and issues in modern engineering are discussed including construction buildings and structures advanced materials innovative technology methods and techniques in civil engineering heating gas supply water supply and sewerage foundation engineering BIM structural reliability durability and monitoring special and unique structures construction bridge tunnel road railway engineering design and construction of hydraulic structures concrete engineering urban regeneration and sustainable development urban transport system engineering structure safety and disaster prevention water resources engineering water and wastewater treatment recycling and reuse of wastewater etc The volume gathers selected papers from the 8th International Conference on Construction Architecture and Technosphere Safety ICCATS held in Sochi Russia in September 2024 The authors are experts in various fields of engineering and all papers have been carefully reviewed

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