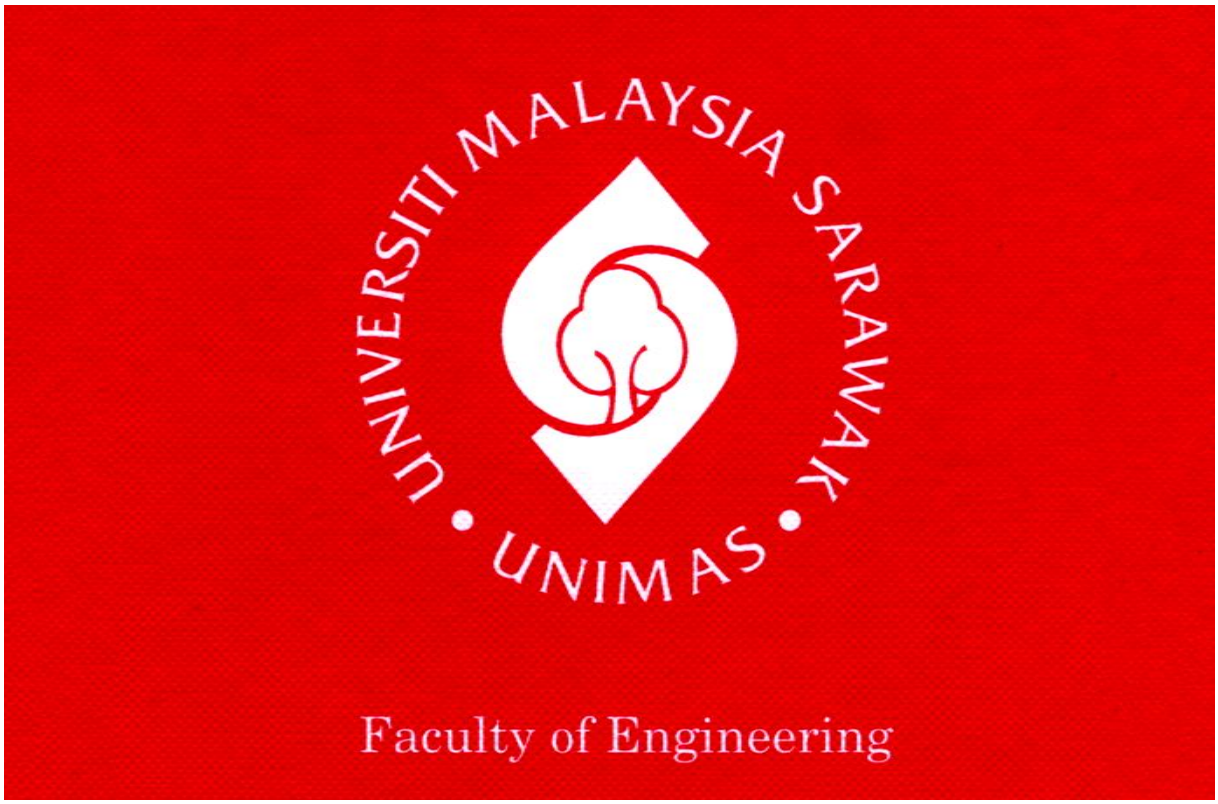

DEVELOPMENT OF SHAPE PATTERN RECOGNITION FOR FPGA-BASED EMBBEDED OBJECT TRACKING SYSTEM

Fauziliana Binti Osman

Bachelor of Engineering with Honours
(Electronic and Computer Engineering)
2010

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Student Name : Fauziliana Binti Osman

Matric No : 16238

has been read and approved by:

_____ _____

Mdm. Maimun Binti Huja Husin Date

(Supervisor)

DEVELOPMENT OF SHAPE PATTERN RECOGNITION FOR FPGA-BASED EMBBEDED OBJECT TRACKING SYSTEM

FAUZILIANA BINTI OSMAN

This project is submitted in partial fulfillment of
The requirements for the degree of Bachelor of Engineering with Honours
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Faculty of Engineering
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Dedicated to my beloved family and friends.

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ABSTRAK

Projek ini memperkenalkan FPGA, *Field Programmable Gate Array* sebagai asas untuk sistem pengesanan objek terbenam. Rekabentuk pengesanan ini menggunakan FPGA yang kaya dengan informasi di mana FPGA menawarkan salah satu idea yang sangat kuat dalam sistem pengesanan objek sebagai contoh sistem kamera pengawasan di kilang. Sistem pengesanan objek ini dikenali sebagai sistem yang sangat berguna dalam kebanyakan aplikasi nyata yang memerlukan pengesahan objek. Terdapat pelbagai algoritma yang sedia ada termasuklah pengesanan tulisan tangan, pergerakan orang, haiwan dan kod bar. Projek ini fokus kepada pengesanan bentuk objek untuk mengkaji antara bentuk asal dan bentuk yang dihasilkan melalui experimen. Bentuk yang terkandung adalah seperti segiempat sama, bulatan, segi tiga dan sebagainya. Imej hitam dan putih yang digunakan dalam rekabentuk ini akan di tukar kepada isyarat binari sebelum memasuki proses pengesanan. Selepas itu, sistem rekabentuk akan dibenam ke dalam FPGA untuk mengesahkan bentuk yang diperolehi melalui perisian Quartus II Altera. Piksel yang di kesan mewakili kewujudan intensiti di dalam imej. Tiada kesalahan atau pembetulan disertakan ke dalam sistem. Sistem ini cuma mewakili imej tetap tanpa getaran dan penambahan.

ABSTRACT

This project presents FPGA (Field Programmable Gate Array) based solution for an embedded object tracking system. The tracking design was applied at FPGA as rich information of FPGA offers one of the powerful ideas in object tracking system. Object tracking system well-known as the system that is very useful in most real application that requires object detection, for example factory camera surveillance system. There are lots of algorithms available including the detection of handwriting, moving people, animals and the barcode number. This project will focus on shape detection to observe the real object image and the expected experimental object shape image. Shapes that cover are square, circle, triangle and etc. The black and white image will be used in the design and will be converted to binary signals before entering the tracker process. Then the design system will be embedded to the FPGA to confirm the shape that obtained using Quartus II Altera software. The pixels detected represent the available of intensity within the image. No error and correction included in the system. The system represented only fixed image without noise and no assorted.

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LIST OF ABBREVIATIONS

2D	-	Two Dimensional
CG	-	Computer Graphic
DAC	-	Digital to Analog Conversion
DDR	-	Double Data Rate
DSP	-	Digital Signal Processing
FPGA	-	Field Programmable Gate Array
FSM	-	Finite State Machine
GPRS	-	General Packet Radio Service
GPS	-	Global Positioning System
HDL	-	Hardware Description Language
HSI	-	Hue, Saturation and Intensity
HTTP	-	Hypertext Transfer Protocol
ITDOA	-	Inter-node Time Difference-Of-Arrival
LED	-	Light Emitting Diode
LUT	-	Look Up Tables
MATLAB	-	Matrix Laboratory
MHz	-	Megahertz
NS-2	-	Network simulator 2
NTSC	-	National Television System Committee
PC	-	Personal Computer
POST	-	Power-on Self-test

RAM	-	Random Access Memory
RFID	-	Radio Frequency Identification
R,G,B	-	Red, Green, Blue
RISC	-	Reduced Instruction Set Computer
ROM	-	Read Only Memory
RTL	-	Register Transfer Level
SIFT	-	Scale Invariant Feature Transform
SRAM	-	Static Random Access Memory
VGA	-	Video Graphic Array
VHDL	-	Very High speed integrated circuit Hardware Description Language

CHAPTER 1

INTRODUCTION

This project presents the FPGA based solution for shape pattern recognition with an embedded object tracking system. The tracking design was applied at an integrated electronic device which performs an image processing application to track and recognize object shape. This rich information of FPGA offers one of the powerful ideas in object tracking system.

1.1 Project Overview

Object tracking system already known throughout the world as the system that basically detects any particular or selected object. Different tracker system algorithm detects different object, this include the detection of handwriting, moving people, animals and the barcode number. Due to the growth of technology and the increasing camera system for surveillance, the demand to improve the quality and the accuracy for object tracking also increase.

Lots of domestic and overseas researchers have done lots of work and built many tracking algorithms, models and systems. They are applied gradually in many military and civil fields, such as military exposure, medical diagnosis, safety surveillance, traffic management, satellite measurement and computer vision [1].

The entire object tracking system usually includes sensors, image processing application, hardware controller, pan and tilt camera, and monitoring system. The image processor has four typical modules of system management, video capture, data processing, video display and output. Its kernel device to development image data of great capacity for liquor is a high-performance DSP (Digital Signal Processor), or several parallel DSPs, or one or several large-scale FPGAs or DSP and FPGA [2].

This project aims to design and develop object tracker system with FPGA in term of recognize the object shape. This can be achieved by analyzing the performance of different algorithms. The top ranked algorithms will be selected to develop the tracking system. There are four possible configurations to detect the images for this object tracker system;

i. Stationary camera, Moving objects
ii. Moving camera, Stationary objects
iii. Moving camera, Moving objects
iv. Stationary camera, Stationary objects

In this project, the research is based on stationary camera for stationary objects.

1.2 Problem Statements

Object tracker systems commonly use the RFID function, Neural Network system, Sensor application and software implementation by using MATLAB simulation. The reasons why there is a very small scale of FPGA being applied compared to other methods are stated as below:

i. Circuit debugging

Circuit debugging is significantly more complex and troublesome on an FPGA particularly in a standalone configuration which lacks of operating system to control basics tasks such as user interaction and peripheral interfacing [3].

ii. Circuit testing

Further debugging circuitry must be built in tendem to perform these tasks even if they are not required in final system [3]. This is because of performance of a real time application processing is continuous and noisy, so the video stream will difficult to evaluate without actually having the final system [4].

FPGA is very reliable as it offers low power consumption and low cost budget under one single chip. Therefore, the FPGA is the main key for this image processing applications because of the structure can exploit spatial and temporal parallelism.

1.3 Objectives

The objectives of this project are:

a) To design and develop on object tracker system using Quartus II Altera Software that will able to recognize object shape.

b) To identify the object shape based on the result from the FPGA board.

1.4 Scope of Project

The aim of this project is to design a system that will be able to detect an object shape in image of interest. This system was designed using FPGA with HDL as the main hardware description language for the FPGA to function. The HDL is written on QUARTUS II Altera software. Then, it will be implemented on Altera development board and performs the tracking ability of the image input by the users. The program can obtain image from an offline image or a real-time image, obtained from camera or video that interfaced with the system. This project aims to detect in 8 × 8 pixels of black and white image and with some further adjustment hopefully it can be accomplished for larger and real image. The analysis is done in order to search for the best method in solving the tracking problems such as noise and tracking abilities.

1.5 Project Outline

This Final Year Project's Report is organized into 5 chapters. The brief information of each chapter is described as below:

Chapter 1 provides a brief introduction of object tracker system project. This chapter also contain problem statement, project scope and followed by the objectives to be achieved.

Chapter 2 is devoted to the studies, researches and readings process that have been carried out. It also reviews the difference methods of tracker algorithm and type of object representation used to complete the prototype system.

Chapter 3 explains the methodology for development, analysis process and focuses on the designing the system through the methods selection to satisfying the design requirement. It also describes the detailed hardware specification for the tracker system where the requirements are reviewed.

Chapter 4 evaluates the performance and results for the tracker system. Result and analysis based on the project are presented in this chapter. Chapter 5 contains discussion based on the analysis and result from previous chapter. In addition, further research and recommendation for this project are also being discussed in this chapter.

CHAPTER 2

LITERATURE REVIEW

This chapter provides information from past research and existing methods on object tracker system using FPGA. An extensive literature review was conducted with the most relevant results presented in this chapter.

2.1 Introduction

Tracking can be defined as difficulty of estimating the trajectory of an object in the image plane as it moves around a scene. It's also referring as a tracker assigns consistent labels to the tracked objects in special frames of a video. The tracker can give the object-centric information likes orientation, shapes and area for the selected object depending with tracking domain and tracker capabilities. By applying this motion to preceding frame and compare it with the existing frame, moving object can be detected. The related application for this object tracking system is such as [5];

i. Motion-based recognition used for human identification based on gait or automatic object detection.

ii. Automated surveillance used to monitoring a scene to detect suspicious activities or unlikely events.

iii. Video indexing used for automatic annotation and retrieval of the videos in multimedia databases.

iv. Human-computer interaction by gesture recognition or eye gaze tracking for data input to computers.

v. Traffic monitoring for real-time gathering of traffic statistics to direct traffic flow.

vi. Vehicle navigation for video-based path planning and obstacle avoidance capabilities.

2.2 Reviews from Other Project

In year 2001, Paul G.V., Beach G.J. and Cohen C.J. have implemented a real time object tracking system using a color camera. The project is based on a color camera and a personal computer which the system is able to track colored objects in the camera view in real-time. The algorithm uses the color, shape and motion of the object to attain robust tracking even in the presence of partial occlusion and shape change [6].

In year 2002, Chao He, Zheng Y.F and Ahalt S.C. proposed an object tracking using 2-D Gabor wavelet transform and 2-D golden section algorithm. Amplitudes of the Gabor wavelet transform coefficients of a feature point are then used as the local feature. This takes benefit of the characteristics of Gabor wavelets which are much localized in both time and frequency domains. The 2-D golden section algorithm is employed in order to find the corresponding object in the next frame and this can be shown to be the fastest algorithm to find the maximum of a unimodal function [7].

In year 2003, Moritani T., Hiura S. and Inokuchi S. proposed object tracking by comparing CG images with multiple viewpoint images. They use a model based method using intensity images taken with a multiple view point camera connected to PC cluster system. To track the object, numerous CG image with varied object pose and position are generated in each PC using the object model and then compared to the input intensity image in parallel [8].

In year 2004, Mei Han, Sethi A., Wei Hua and Yihong Gong proposed a detection-based multiple objects tracking method for tracking multiple objects whose number is unidentified and varies during tracking. The multiple objects tracking method keeps a graph structure where it maintains multiple hypotheses about the number and the trajectories of the objects in the video. This method gives feedbacks which are predictions of the object locations to the object detection module [9].