TARGET DETECTION IN SATELLITE IMAGES

Project Report Submitted by

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CERTIFICATE

*Certified that the project work entitled **Target Detection in Satellite Images** carried out by **Ms. Annette Nayana Palanna, USN 4NM15LVS01**, a bonafide student of **N.M.A.M. Institute of Technology, Nitte** in partial fulfillment for the award of **Master of Technology in VLSI Design and Embedded Systems** of the Visvesvaraya Technological University, Belagavi during the year **2016-17**. It is certified that all corrections / suggestions indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of Project work prescribed for the said Degree.*

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This is to certify that **Ms. Annette Nayana Palanna** , bearing **USN: 4NM15LVS01,** student of "**NMAMIT Nitte, Karkala",** has carried out the Project **"TARGET DETECTION IN SATELLITE IMAGES"** in SSP Group from 17th June 2016 to 10th May 2017. This Internship is towards the partial fulfilment of requirements for the award of "**Master of Technology (VLSI & Embedded Systems)"** Degree. It is certified that she has completed the Project Work satisfactorily.

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ABSTRACT

In the field of image processing, image segmentation is widely used to extract the Region Of Interest (ROI) from a digital frame. In this project, a block-based approach is used for segmenting a high resolution satellite image. An unsupervised approach is employed for the purpose of segmentation. A new optimal automatic thresholding method for the selection of threshold is proposed for segmentation. The proposed model is based on histogram segmentation and template matching method. The segmented output has labels corresponding to different contours. Further morphological dilation is used for the creation of mask image. Template matching is carried out to check for the true targets. In this project, an efficient template matching method is proposed on the basis of correlation score. The proposed method is implemented in MATLAB R2014a and is tested on various remotely sensed satellite images of different resolutions and complexity levels. The algorithm is able to perform segmentation and detection of ROI more effectively with less missed targets. To check systems performance on a practical system, the design is implemented on an Altera EP3C120F78017 FPGA chip and QUARTUS II software tool.

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NOMENCLATURE

FPGA	Field Programmable Gate Array
HDL	Hardware Description Language
HSMC	High Speed Mezzanine Card
IC	Integrated Circuit
IDE	Integrated Development Environment
ISE	Integrated Synthesis Environment
PAL	Phase Alternating Line
PCB	Printed Circuit Board
PLD	Programmable Logic Device
PLL	Phase Locked Loop
RAM	Random Access Memory
ROI	Region Of Interest
ROM	Read Only Memory
RTL	Register Transfer Logic
SOPC	System On a Programmable Chip
SRAM	Static Random Access Memory
VHDL	VHSIC Hardware Description Language
VHSIC	Very High Speed Integrated Circuit

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CHAPTER 1

INTRODUCTION

Satellite images are rich in providing geographical information. Therefore, there is a strong requirement of powerful and streamlined mechanisms to extract and explicate valuable information from massive satellite images for military applications. Segmentation is a method of allocating a label to every block in an image such that blocks with an identical label contribute to some common characteristics [1]. Thus, covering the whole image or contours extricated from image. There are plenty of manmade structures of interest such as buildings, vegetation areas or count of vehicles which are considered for the study from satellite or aerial images [5].

An existent scenario as seen from a satellite image comprises of various features, textures and shadows and it can therefore be very hard to find the ROI. The gripping part of a satellite image depends on the field of application employed for extraction of target [11]. There are numerous techniques to identify the clusters corresponding to ROI. Thus segmentation is focused for extracting different features or textures inside an image and is performed in numerous ways using the image properties.

Among many segmentation approaches existing in the literature, Thresholding is one of the convenient and favorable techniques employed with regard to intensities in an image. The application relies on the assumption that target and its background region in the image can be differentiated by their gray level threshold [2]. In this project, based on image histogram a threshold value is chosen automatically. The concept of histogram segmentation is to classify an image by an optimal threshold value. This is done by using Kittler’s thresholding algorithm which automatically generates the threshold [20].

The main two types of classification techniques reported in the literature are supervised and unsupervised techniques [14]. Supervised classification focuses on training samples that are applied to classify the satellite image. In this project, unsupervised classification technique is employed owing to histogram segmentation. The pixels with constant window size are segregated into different groups in accordance with the pixel intensity and thus assigned with different labels [11]. The extent to which an image is segmented depends on the output that is demanded by the application. Therefore the conclusive way is to use a blend of different image processing methods to identify the interested areas.

Template Matching is a high level machine-vision technique that identifies a particular region of an image and matches to a prefixed template image. The highest value of correlation indicates that there is a match amongst the considered image patches. In general this method includes its unique algorithm to compare the chosen patch image with the source image and finds its similarity content [7].

The need to develop the algorithm in real time, leads to implementation in hardware, which supports parallelism, thus significantly reducing the processing time [7][8]. This project proposes the real time implementation of segmentation procedure to detect the ROI in the optical satellite image employed in military scenarios. The entire work is implemented in MATLAB and the output is verified with the very high speed integrated circuit hardware description language (VHDL) code required for hardware implementation.

1. 1 MOTIVATION

The extrication of ROI from an image is a thorough tough process using single image segmentation technique due to complexity level existing in the satellite images.

The extent to which an image is segmented depends on the output that is demanded by the application. Therefore the conclusive way is to use a blend of different image processing methods to identify the interested areas. The segmented image acquired by thresholding consumes lesser space for storage, rapid speed in processing and ease in manipulation, in comparison with a gray image containing 256 levels.

Target extraction approach makes use of captured information or footage which does not require any complex hardware thus making it inexpensive and easy to use. This thesis manifests a feasible solution for the segmentation problem. The initial process is determined by detecting the possible targets by segmentation from the image under consideration. Further using this output, classification of targets into true, missed or false estimation is carried out.

1.2 OBJECTIVE

The prime concern of this research lies in extricating targets from satellite or aerial images using block-based unsupervised segmentation method and validating the presence of targets using correlation coefficient.

1.3 PROBLEM DEFINITION

Target detection from optical satellite images play an important role in military and civil related domains and its drawback lies in its compromised interpretation under challenging flicker conditions. In this work, a novel automatic ROI finding technique is proposed to overcome this issue.

The objective of the thesis work is to detect and extract targets such as army camps, military bases, aircrafts etc from satellite or aerial images pertaining to military scenarios in real-time.

1.4 THESIS OUTLINE

This thesis is structured into 6 chapters.

Chapter 1 gives a brief introduction on ROI segmentation and Template matching. This chapter includes the motivation behind the research work, objective, and problem definition associated with the project.

Chapter 2 discusses the literature study relevant to the research work.

Chapter 3 discusses the proposed target extraction design methodology with a general block diagram with related expressions. The project discusses on segmentation to obtain the targets and hence validating the extracted targets using template matching phenomena.

Chapter 4 is about the software module description and a brief introduction related to hardware tool inclined in the research work.

Chapter 5 discusses the MATLAB results and simulation waveforms obtained for the proposed work.

Chapter 6 is about the conclusions deduced from the research work.

The last section lists the reference papers, journals, books and webpages that is referenced for the evolution of this project thesis.

CHAPTER 2

LITERATURE SURVEY

This survey includes numerous images, image segmentation, threshold techniques and previous work for detecting the ROI. A literature survey has been conducted to understand the current and past research trends in automated satellite imaging systems domain.

Tong et al., 2017 [1] describes the hierarchical saliency and density-based method for ROI extraction in large scale remote sensing images. In saliency-based method, multilevel histogram contrast is employed to suppress background details. To reduce the count of ROIs obtained, super-pixel segmentation is performed. Depending on the user selection of ROI to be extracted, density-based method on the basis of adaptive threshold and centroid selection is proposed. Higher accuracy was achieved for experiments conducted on extracting ROIs of tanks and residence from a large scale images.

A paper by K.Suresh et al., 2016 [2] describes a non-parametric technique to determine the global threshold. A detailed comparison based on Kapur/Tsallis function and Firefly algorithm is done considering the performance measure. The approaches are tested on Berkeley segmentation dataset. It is observed that entropy based algorithm gives good image quality measures.

Zhongwen et al., 2016 [4] introduced a block-based supervised segmentation approach for urban area detection from high-resolution optical and SAR images. Several features are extracted from each block of image. K-means clustering technique is used for segmentation purpose. Targets are choosen by thresholding. Experiments are conducted to extract buildings from SAR images of different resolutions and hence proving the robustness of the proposed technique.

A paper by Warinthorn et al., 2016 [5] proposes methods to segregate the targets in the satellite image using ROI extraction scheme. The author uses histogram segmentation to obtain the targets. The major drawback of this approach is manual threshold selection. Hence the proposed approach implements automatic threshold selection from the content of the histogram and identifies interested targets in image. The block-based approach has advantages in interpreting built-up areas when compared to the traditional pixel and object-based approaches.

A paper by Amit et al., 2016 [6] attempted to present automated technique to accurately identify the building from remotely sensed high resolution panchromatic images. To improve the contrast of the buildings, image enhancement technique is employed. Further, internal gray variance method and digital surface model technique is considered to extract the homogenous buildings by extracting its corner points. Image segmentation is done by non-parametric approach. The result concludes that the proposed technique is very precise and effective in comparison with other algorithms reported in the literature.

Aditya et al., 2016 [8] introduced hardware implementation of template matching phenomena using binary sum of absolute difference method on satellite images. The entire algorithm was designed to match 40x40 pixels at once. The design is tested on Altera Quartus II simulator and implemented on Altera DE2 development board having clock frequency of 50 MHz.

A paper by Yuri et al., 2016 [10] proposed co-design approach, where the correlation coefficient computation is implemented in hardware and Particle Swarm Optimization process in software. Thus this system can be used for real-time execution for pattern tracking. The major concern of the author is to develop portable devices for real-time applications. One major drawback lies in the pixel-wise computation of correlation coefficient. The overall processing time for the images is found to be high when compared to the software only implementation.

A paper by Aarti Sharma, 2015 [13] focuses on automatic vehicle detection using various object detecting algorithm and thresholding methods.Vehicle detection from satellite image is developed using morphological recognition algorithm in MATLAB and this thesis compares two thresholding techniques like pixel thresholding and Otsu thresholding method to get the best result. The result concludes that pixel level thresholding is better than Otsu method. Here image complementation are not used which make system more powerful and make system highly applicable. The result concluded that pixel level thresholding or block based thresholding is better than Otsu method for detecting the vehicles from satellite imaginary.

CHAPTER 3

METHODOLOGY

3.1 OVERVIEW

Spatial resolution is a prime feature to be taken in to account for target detection in satellite images. Images with high spatial resolution are considered for the study which provides detailed information of an area. The aim of the proposed system is to arise with a robust algorithm for automatic detection and classification of the targets from high-resolution satellite images in real-time.

The block diagram of the proposed system is shown in Figure 3.1. It involves converting the original high resolution raw image into a grayscale image followed by some preprocessing techniques to remove the noise. The image pixel values are represented in terms of histograms. Histogram thresholding is the cheapest and fastest techniques for unsupervised image classification. The concept of histogram segmentation is to classify an image by a threshold value. This is done by using Kittler's thresholding algorithm which automatically decides the threshold and further performs unsupervised segmentation. Kittler's non-parametric method defines a criterion with regard to the assumption that the histograms of the changed and unchanged pixels are normally distributed and a threshold is selected by minimizing this criterion. The unsupervised approach attempts for classification without any prior knowledge from the user. Thus the segmented image consists of several labels, which in turn represents different associated regions. In binary image, targets are labeled as 1 and remaining labels are 0. There is a possibility of the existence of some unwanted pixels in the binary image which is removed using area criterion. Morphological dilation is performed on the binary image to get the mask image. Further with this mask, template matching is done to validate the presence of targets. Bounding box is put around the ROI. Only the proposed segmentation algorithm is converted to HDL code for the purpose of hardware implementation on Altera FPGA.

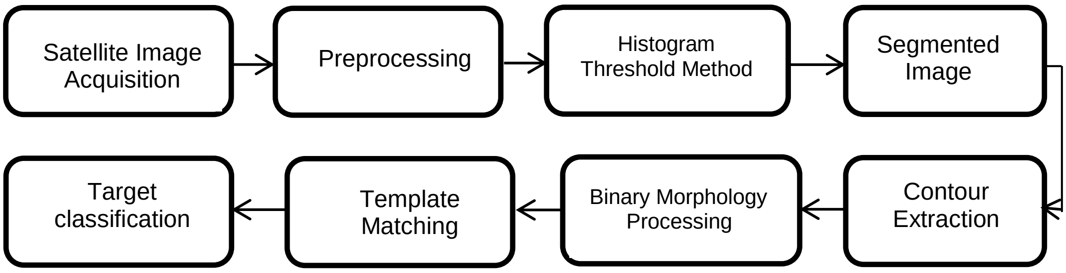

Figure 3.1 Block diagram of the overall system.

3.2 DESIGN STEPS

The main idea of the technique employs unsupervised segmentation method to classify the regions (labels) using automatic threshold. The final image will be composed of all the regions used for extraction of ROI from the original image.

3.2.1 Satellite Image Acquisition

The main two steps involved here are reading the raw satellite high resolution image in .jpeg format and resizing the image for further processing [5]. The importance of resizing the image will reduce the processing time [14].

3.2.2 Preprocessing

The second step involves conversion of color image into a grayscale image [16][17]. However, some images collected by satellites have low signal-to-noise ratio. In order to improve the quality of images, they must be processed to reduce distortions or enhance some features required for further processing. Noise reduction or contrast enhancement techniques like histogram equalization and intensity adjustment techniques are of great interest in image analysis that improve image quality [6].

3.2.2.1 Histogram Equalization

Histogram equalization is a technique to enhance contrast of an image by considering intensities [10]. Let *I* be an image represented as a $M \times N$ matrix of integer pixel intensities ranging from *0* to *L* − *1*. Where *L* indicates the number of possible intensity values often 256. Let *N* be the normalized histogram of *I* with a bin for each possible intensity.

$$N_n = \frac{\text{number of pixels with intensity n}}{\text{total number of pixels}} \quad n = 0,1,\ldots,L-1. \quad \ldots\ldots \quad (3.1)$$

The histogram equalized image g will be defined by

$$g_{i,j} = floor((L-1)\sum_{n=0}^{I_{i,j}} N_n) \quad \ldots\ldots \quad (3.2)$$

Where floor() rounds down to the nearest integer. This is equivalent to transforming the pixel intensities *k* of *I* by the function

$$T(k) = floor((L-1)\sum_{n=0}^{k} N_n) \quad \ldots\ldots \quad (3.3)$$

The transformation is by considering the intensities of *I* and *g* as continuous random variables X, Y on [0, L − 1] with Y defined by,

$$Y = T(X) = (L-1)\int_0^X N_X(x)dx \quad \ldots\ldots \quad (3.4)$$

Where N_X is the probability density function of *I*. *T* is the cumulative distributive function of X multiplied by (L − 1).

3.2.3 Histogram Threshold Method

The Histogram based threshold method considers histogram of an image as probability distribution and chooses a valley point as a final threshold value [19]. A new optimal threshold selection for image segmentation is found automatically by using Kittler and Illingworth Algorithm [12]. This is minimum error thresholding method, outperforming all the other existing methods like Otsu, Kapur thresholding etc., in their computational speed and also by defining fine and sparse details of the image under consideration by performing experiments on various military images.

In practical scenarios, images used for target detection contains two modes in their histogram [3]. Figure 3.2 shows a bimodal histogram for target and Non-target regions.

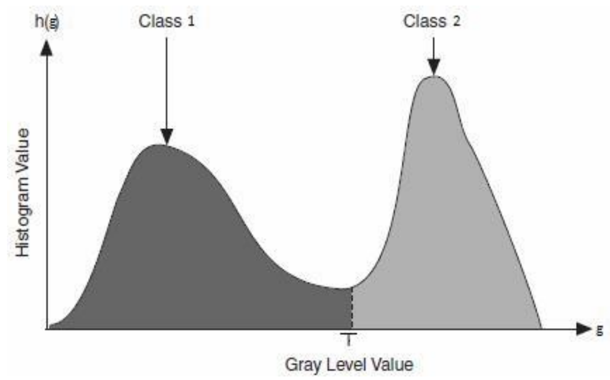

Figure 3.2 Bimodal histogram [3].

A grayscale image is a mix of white and black colors ranging from 0 to 255 intensity levels. Where 0 represents black color and 255 for white color. Depending on the location of targets on the grayscale histogram, threshold selection is divided into three categories. The three categories are

- Dark targets
- Medium gray targets
- Bright targets

For the image considered in Figure 3.3, it is observed that dark targets are found on brighter background and threshold obtained by Kittler's is 56. Figure 3.4 shows the histogram of the image. The pixel intensities below this threshold belong to target area or foreground and intensities above this threshold belong to the background area. Since the target lie in the first half of histogram, region greater than threshold is considered for segmentation.

Figure 3.3 Image of dark targets.

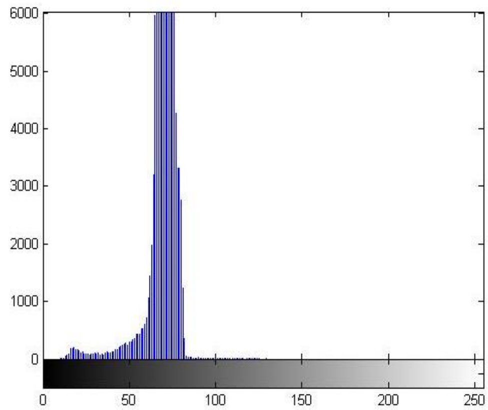

Figure 3.4 Histogram representation.

Figure 3.5 depicts the presence of medium gray shade targets on a similar shaded background. The histogram in Figure 3.6 shows that there is no much demarcation of targets from the background, making selection of threshold even more difficult. Hence histogram equalisation is performed on the image under consideration and is shown in Figure 3.7. The automatic threshold for the image is found to be 190. The equalised histogram of the image is shown in Figure 3.8. Since the target as seen from the equalized image is found to be brighter when compared to background, region less than the threshold are chosen for the study.

Figure 3.5 Image of medium gray targets.

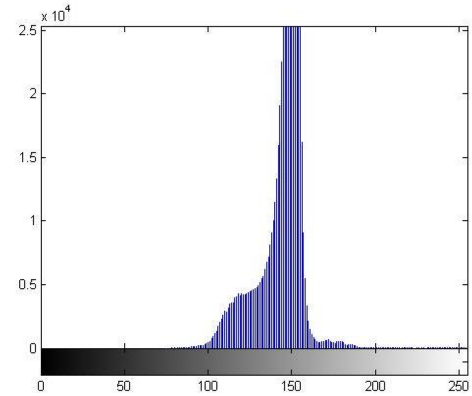

Figure 3.6 Histogram of the image.

Figure 3.7 Histogram equalised image.

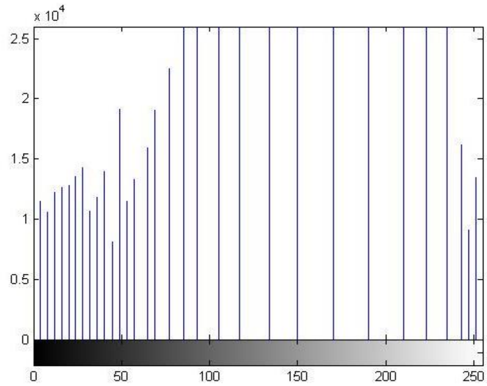

Figure 3.8 Equalized histogram.

Figure 3.9 shows image consisting of bright gray shaded targets on darker background. The histogram of the image is shown in Figure 3.10. It is noticed from the histogram that there is a clear cut separation between target and surroundings. The optimal threshold is found to be 120. Hence the pixels with intensities lesser than threshold is considered as the criterion for segmentation.

Figure 3.9 Image of bright targets.

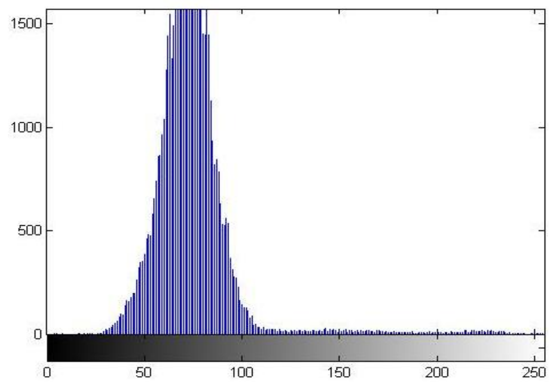

Figure 3.10 Histogram of the image.

The algorithm is as follows:

Step 1: Let us assume components of bimodal histogram in a gray-level image *h(g)* are normally distributed [23].

Step 2: For a case of two different classes (i = 1, 2) the background and foreground and given a threshold T, the parameters can be estimated from the following:

Priori probability, $P_i(T) = \sum_a^b h(g)$ …… (3.5)

Mean, $\mu_i(T) = \frac{1}{P_i(T)} \sum_{g=a}^{b} h(g)g$ …… (3.6)

Standard deviation, $\sigma_i^2(T) = \frac{1}{P_i(T)} \sum_{g=a}^{b} h(g)(g - \mu_i(T))^2$ …… (3.7)

Where, $a = \begin{cases} 0 & i = 1 \\ T+1 & i = 2 \end{cases}$ and $b = \begin{cases} T & i = 1 \\ n & i = 2 \end{cases}$

n is the upper limit of the histogram.

Step 3: The criterion function is given by,

$$J(T) = 1 + 2[P_1(T)\log\sigma_1(T) + P_2(T)\log\sigma_2(T)] - 2[P_1(T)\log P_1(T) + P_2(T)\log P_2(T)] \quad \ldots\ldots \quad (3.8)$$

Step 4: The minimum error threshold can be computed by minimizing the criterion $J(T)$.

The advantage of this method is that only a single pass through the image is required. However, this method is dependent on the block size taken for scanning over the image.

3.2.4 Image Segmentation

Image segmentation is done using pixel intensity property of the pixels [5]. Thresholding techniques use intensity property of the pixels for segmenting the image. The block-based unsupervised clustering approach employed in this work is by kittler’s non-parametric thresholding technique which uses membership criterion to segment the image satisfactorily, hence extracting the appropriate ROI [4][20][23][24].

The algorithm is explained briefly as follows:

Step 1: Select a Threshold (T) by Kittler’s method.

Step 2: Select a block with measurement vector x_1.

Step 3: Let first block be taken as first cluster with center Z_1.

Step 4: Select next block from the image x_2.

Step 5: Compute the membership criterion defined by,

$$D_i(x) = \sum_i^M \sum_j^N |x_1 - x_2| \quad \ldots\ldots \quad (3.9)$$

Where, M x N is the size of the original image.

Step 6: Compare $D_i(x)$ with T. If $D_i(x) < T$ then assign appropriate label beginning from label1 else return to step 4 until all pixels are assigned to a class.

Step 7: After all pixels are assigned to a cluster center, recompute $D_i(x)$ and assign the labels appropriately.

The final image is purely segmented with different labels associated with the image obtained.

3.2.5 Contour Extraction

The segmented image consists of numerous labels associated with various contour representations. In this step, the labels pertaining to large and small contours are nullified. The pseudo code for redefining the segmented label array in obtaining the labels of interest is mentioned below. The ROI region in a binary image is assigned with value '1' (white) where as Non-ROI region with value '0' (black). Thus, this process gives contour image associated with several targets and less background details.

The Pseudo code is as follows:

$for\ i \leftarrow 1: maximum\ of\ segmentlabelarray$

$labelcount \leftarrow find\ in\ segmentlabelarray$

$end\ for$

$//\ Removal\ of\ labels\ associated\ with\ minimum\ label\ count.$

$A = sort\ labelcount\ in\ descending\ order$

$for\ ii \leftarrow 1: minimum\ counted\ labels$

$segmentlabelarray(ii) \leftarrow 0$

$end\ for$

$//\ Removal\ of\ labels\ associated\ with\ maximum\ label\ count.$

$for\ iii \leftarrow 1: length\ of\ labelcount/2$

$segmentlabelarray(iii) \leftarrow 0$

$end\ for$

3.2.6 Binary Morphology Processing

The binary contour image contains many irrelavent objects. In this project, a parameter based on area of contours is considered to remove contours larger than the template [1][14]. Thus, a detailed contour image containing the ROI is obtained. This image is further subjected to Dilation to obtain the mask image. Morphological Dilation enlarges the boundaries of the extracted contours (i.e. white pixels) on a contour image [5][6]. The Dilation operator has two data inputs. The first one is the binary image which has to be dilated and the second one is the square structure element (kernel) of dimension 2 x 2.The next step is to overlay the targets on the original image. Overlaying the result helps to enhance the accuracy of the target extraction. In order to accomplish this operation, rectangular bounding box based on the contours is drawn around the target in yellow color.

3.2.7 Template Matching

In this project, Template Matching is based on normalized form of correlation (correlation coefficient) [12][20]. It will calculate the mean value of each image and then by calculating correlation score it will match the template image with source image [7]. The correlation coefficient (c) is given by,

$$c = \frac{\sum_m \sum_n (A_{mn} - \overline{A})(B_{mn} - \overline{B})}{\sqrt{\left(\sum_m \sum_n (A_{mn} - \overline{A})^2\right)\left(\sum_m \sum_n (B_{mn} - \overline{B})^2\right)}} \quad \ldots\ldots \quad (3.10)$$

Where, A_{mn} = Source image of prefixed size m x n.

B_{mn}=Template image of prefixed size m x n.

$\overline{A}$ and $\overline{B}$ = mean of A and B respectively.

The block diagram of correlation coefficient is given in Figure 3.11.

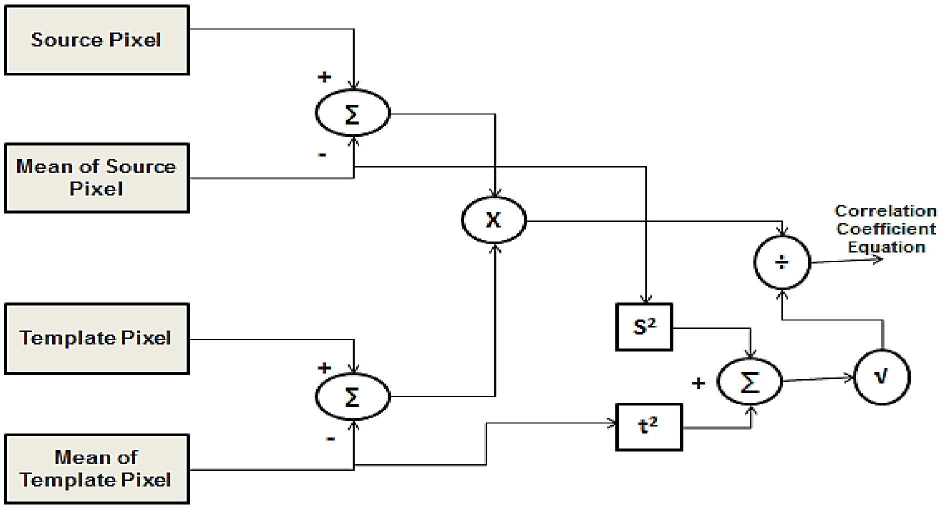

Figure 3.11 Correlation coefficient block diagram [12].

The algorithm is explained in the following steps below:

Step 1: Load Template Image with predefined window size.

Step 2: Load source Image.

Step 3: Load ROI Mask Image.

Step 4: Convert both Input images to gray image

Step 5: Find the mean and correlation coefficient values of template and source images of equal size.

Step 6: Check in entire binary mask image if Correlation coefficient value > 0.9. If so, then template is matched and target is confirmed.

Step 7: Draw Bounding Box around the target in red.

3.2.8 Target Classification

This is the last step of the work, where the ROI image and the template matched images are compared [5]. If the targets present in both the images are same, then it is classified as true target. If the targets are missed in the ROI image they fall under missed target category. The rest are classified under false target category [9]. In addition, the efficiency of the true targets detected is computed.

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CHAPTER 4

SOFTWARE AND HARDWARE REQUIREMENT

4.1 SOFTWARE TOOL

This section gives details regarding the softwares like MATLAB and VHDL used for coding in this work.

4.1.1 Introduction to MATLAB

MATLAB is user-friendly and highly suited for image processing scenarios. Particularly, MATLAB's matrix-oriented language includes built-in commands and math functions which is perfectly suited for manipulating images, implementation of algorithms, user interface, interfacing with high level languages, creation of models and many others. In addition, toolbox in MATLAB provides a flexible and powerful environment for image analysis and processing.

There are numerous benefits of using MATLAB for image analysis. It is possible to stop any calculation anytime with the help of this program, alter a part of the calculation process and then restart the calculations from where it was affected without recompiling the code which usually happens with programming in other languages.

4.1.2 Introduction to VHDL

VHDL is a hardware description language which is designed for characterising the behavior of digital systems. It allows electrical aspect of circuit behavior such as rise and fall times of signals, gate delays and functional operation to be described. The VHDL integrated development environment (IDE) supports hardware design for FPGA implementation of various companies such as Xilinx ISE, Altera Quartus, Synopsys Synplify or Mentor Graphics HDL Designer to produce the register transfer logic (RTL) schematic of the desired circuit. One of the prime applications of VHDL lies in capturing the performance of a circuit in the form of so called test bench. The inputs for a VHDL code or circuit have to be defined accurately for the creation of appropriate test bench.

4.2 HARDWARE TOOL

The Quartus II development software provides a complete design environment for system-on-a-programmable-chip (SOPC) design. The following section describes the design flow of the Quartus II software [27].

4.2.1 Quartus II design flow

The complete Quartus II system comprises of an IDE that includes every step from design entry to device programming.

The design flow is as follows:

Step 1: Setting up the design hierarchy for secure partitioning.

Step 2: Run analysis and elaboration.

Step 3: Create design partitions for secured regions.

Step 4: Create a design floorplan with security attributes.

Step 5: Assigning design partitions to secured regions.

Step 6: Add I/O pins as members of the secured region that sources or sinks the I/O pin.

Step 7: Create security routing interface regions.

Step 8: Make I/O assignments.

Step 9: Make design changes, set netlist type for each design partition and compile.

SignalTap II embedded logic analyser is a system level debugging tool that captures and displays signals in circuits designed for implementation in Altera’s FPGAs. This tool allows to use an existing SignalTap II file (.stp) to run an analysis or to make any necessary alterations. According to the set up conditions, it is possible to capture the data when the SignalTap II logic analyser is triggered.

The features of this tool are namely,

- It uses available internal memory.
- Incremental compilation support.
- Power-up trigger support.
- Megafunction support.
- Probes state of internal signals without using external equipment or extra I/O pins.

4.3 FPGA

4.3.1 Introduction to FPGA

Field Programmable Gate Array (FPGA) is one step ahead in the programmable logic devices. The word Field in the name refers to the ability of the gate arrays to be programmed for a specific function by the user instead of by the manufacturer of the device. The word Array indicates a series of columns and rows of gates that are programmed by the user. FPGA is an integrated silicon chip that can be programmed electrically to implement any digital design [8]. A single FPGA chip consists of millions of logic gates. When a FPGA is configured, the internal circuitry gets established in a way that creates software application to be implemented on hardware. The advantage of FPGAs when compared to processors is that it uses dedicated hardware for processing logic and do not have an operating system. FPGAs are highly parallel in its operation. Thus it provides adequate amount of resources for the operation which in turn enhances the throughput. The internal resources of an FPGA chip consist of a matrix of Configurable Logic Blocks (CLBs) surrounded by a periphery of I/O blocks shown in Figure 4.1. In addition, signals within the matrix of FPGA are routed via programmable interconnect switches and wire routes.

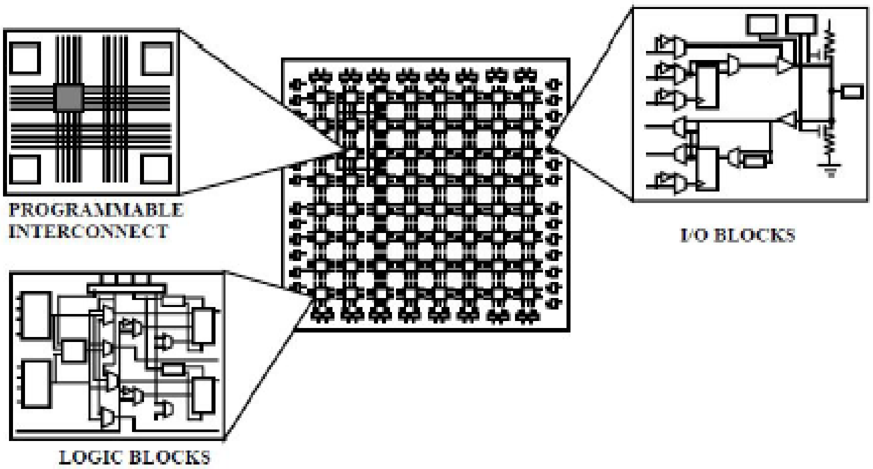

Figure 4.1 Internal structure of FPGA [20].

Logic blocks in an FPGA are implemented using multiple level low fan-in gates and provides a more compact design compared to other existing designs. Routing in FPGAs consists of wire segments of varying lengths which are interconnected via electrically programmable switches. The simplified version of FPGA internal architecture with routing is shown in Figure 4.2.

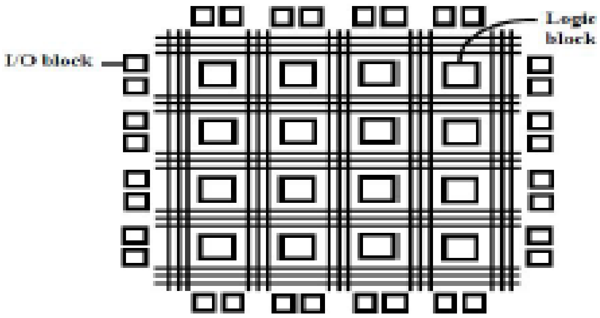

Figure 4.2 Simplified internal structure of FPGA [20].

4.3.2 ALTERA CYCLONE III

Cyclone III device family comprises of a customer-defined feature which is used for portable applications. It provides a good range of density, memory, embedded multiplier and I/O options.

The Cyclone III customised board is shown in Figure 4.3. The board details used in this project contains the following:

- EP3C120F780I7 Cyclone III device
- Two USB blaster connectors
- Euro connector of 96 pins
- Accessory daughter cards: Two loopback high-speed mezzanine connector
  (HSMC) cards and Debug HSMC card
- 5V DC Power supply
- PAL encoder
- Two 20-bit ADC
- DAC of 30 lines
- Four external memories- Synchronous burst SRAM.
- Six regulators
- 50Mhz crystal oscillator
- Two video jacks.

Figure 4.3 Cyclone III customised board

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CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 SIMULATION RESULTS

The designed work is evaluated for a military image acquired from Google Earth. Image in Figure 5.1 corresponds to satellite image covering a Russian military aircraft having size of 444 x 352 is considered for demonstrating the performance over a vast land area.

Figure 5.1 Original image of military aircraft [26].

The huge image is resized to 256 x 256 to reduce computation time and for easier implementation on hardware. Further preprocessing technique is employed and is shown in Figure 5.2.

Figure 5.2 Resized grayscale image of military aircraft.

Figure 5.3 shows the histogram distribution for an image. The pixel values are more intense towards the left side of the histogram which represents the large darker shaded area of the image while right extreme end has lower intensity count representing the minimum bright regions in the image. Hence a well distinguished histogram. Since the targets belong to bright pixels in the histogram, it is necessary to use intensities lesser than threshold for the purpose of segmentation.

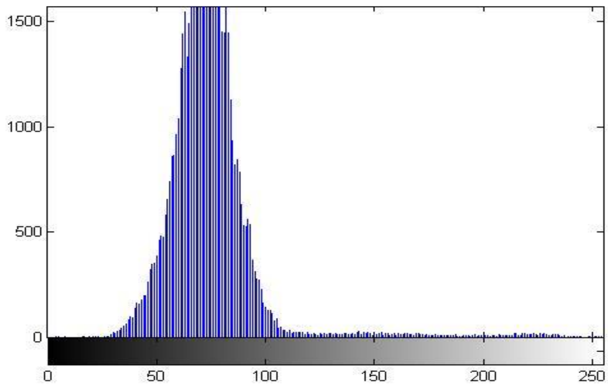

Figure 5.3 Histogram representation of the image.

The proposed non-parametric thresholding algorithm achieves the threshold of 120 from the histogram representation for the considered image. Hence the automatic threshold segments the image into several labels as shown in Figure 5.4, giving label count upto 82. The color blue represents the background and colors except blue represents foreground details.

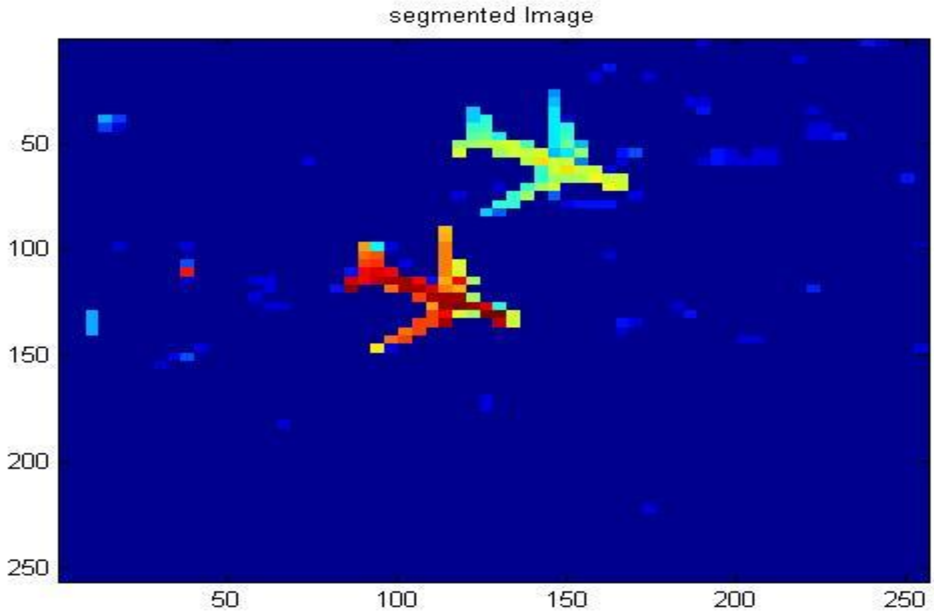

Figure 5.4 Unsupervised segmentation of the image.

The next step is to convert the segmented image into binary by removing the false contours. Hence the ROIs are labeled as 1 and Non-ROIs as label 0. Further reduction of irrelevant targets is achieved using area criterion. Since the targets are identical, common template area of 400 is considered. This image is subjected to dilation using square structuring element of size 2 x 2. Thus the mask image is generated. Figure 5.5 shows the mask image employed for template matching purpose.

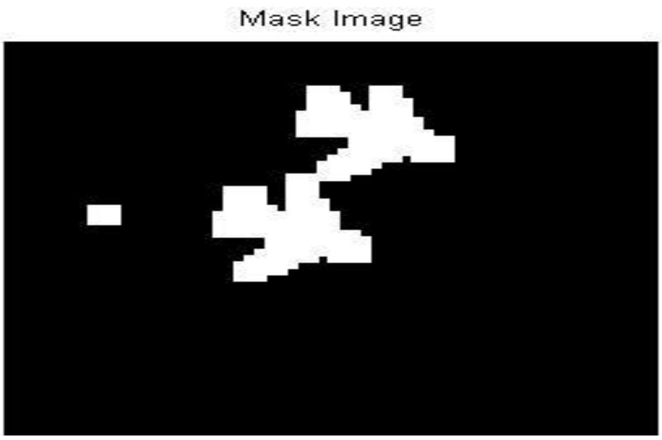

Figure 5.5 Mask image.

Figure 5.6 displays the ROI segmented image achieved using unsupervised segmentation on the basis of membership criterion and threshold. It is noticed that there is one false alarm produced. This is proved to be false by template matching approach. The bounding box in yellow colour represents the targets obtained by segmentation approach.

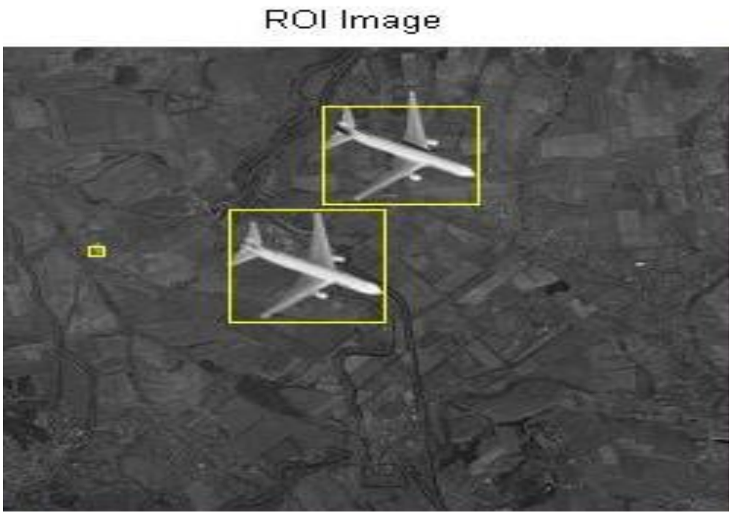

Figure 5.6 ROI segmented image.

Template image of size 20 x 20 is considered for template matching purpose. A common feature of aircrafts is that the shape and size of the similar aircrafts are identical. Thus a single template is taken in this study and is depicted in Figure 5.7. By considering the mask image, template matching is performed using correlation coefficient. Hence true targets obtained are represented in red bounding box as shown in Figure 5.8. The single ROI left out will be classified under false targets. It is noted that, there is no missed targets found in this considered image.

Figure 5.7 Template image.

Figure 5.8 Target classified image.

It is observed that, majority of the manmade structure boundaries are detected. Thus, a qualitative examination of the results shows that the proposed approach is successful in extracting the targets with reduced false alarms.

5.2 PERFORMANCE MEASURES

The performance of the proposed system is evaluated on the considered image for this research work. The CPU time as tabulated in Table 5.1 follows the image size under consideration.

The segmented image is evaluated using the behavior criteria - Region Non-Uniformity (NU) [20]. This measure is defined as

$$NU = \frac{|F_{fg}|}{|F_{fg} + B_{bg}|} \frac{\sigma_{fg}^2}{\sigma^2} \qquad \ldots\ldots \quad (5.1)$$

Where, σ^2 is the variance of the whole image.

σ_{fg}^2 is the foreground variance.

A well-segmented image is expected to pursue a NU measure close to 0. Table 5.1 shows NU measure for image under consideration. It is found that NU for Image is closer to zero. Hence a better segmented image.

The standard of segmented image is measured by analytical framework- Peak Signal to Noise Ratio (PSNR) [2][16]. It is defined as,

$$PSNR = 10\log_{10}(MAX_i^2 / MSE) \qquad \ldots\ldots \quad (5.2)$$

Where, MAX_i is the maximum pixel of the image.

MSE (Mean Squared Error) is the cumulative squared error between the segmented and the source image.

Finally, the accuracy of the true targets detected by the approach is calculated. Here, the output is compared with the ground truth derived manually.

$$Accuracy = \frac{EV}{OV} \times 100 \qquad \ldots\ldots \quad (5.3)$$

Where, EV is the Exact Value obtained from manual count.

OV is the Obtained Value from the proposed algorithm.

The accuracy of detecting true targets from the proposed approach is high as shown in through the results tabulated in Table 5.1. It is observed that, accuracy is lower for images having lesser targets when compared to images with more number of targets.

TABLE 5.1

PERFORMANCE MEASURES FOR THE IMAGE UNDER CONSIDERATION

Images	T	NU	PSNR	CPU time(s)	EV	OV	Accuracy
Image	120	0.0839	0.3741	107	2	3	66.3

5.3 HARDWARE SETUP

In this experiment, the data width of both template and source images are same. The RGB image is transformed into grayscale on MATLAB and stored as a text file. This file in VHDL (.mif) is subjected for further processing. The basic requirements of the proposed system are specified in Table 5.2.

TABLE 5.2

SPECIFICATIONS OF THE PROPOSED DESIGN.

Target Image size	256 x 256 pixels
Template Image size	20 x 20 pixels
Search window size	4 x 4 pixels
System bus width	8- bit
Language	VHDL
Targeted platform	QUARTUS II
Target Device	Cyclone III
Configuration tool	USB blaster

The part of the work is implemented on customized Altera cyclone III FPGA board. The design for ROI extraction is successfully implemented on VHDL. The general architecture of the hardware design is shown in Figure 5.9. In this context, single port RAM 1 is used to store the original image which is considered for algorithm processing. RAM 2 is the dual port RAM focused to store the intermediate results required for further processing. The result image is also stored in this RAM. Finally the output image is seen using the display.

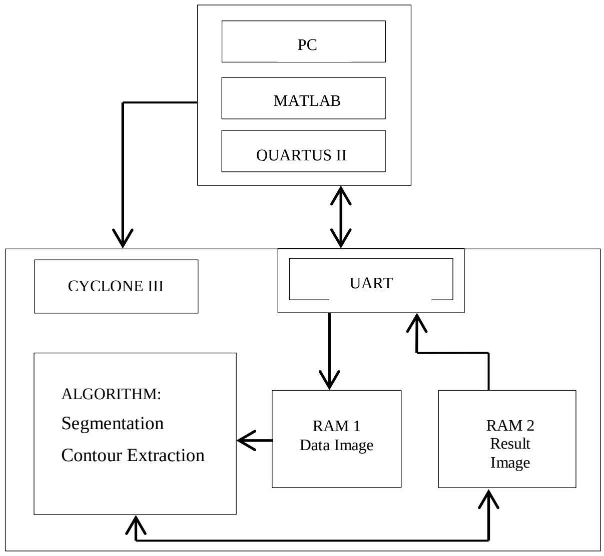

Figure 5.9 General architecture of the hardware design.

The resources utilized and the design flow summary of the generated code is shown in Figure 5.10

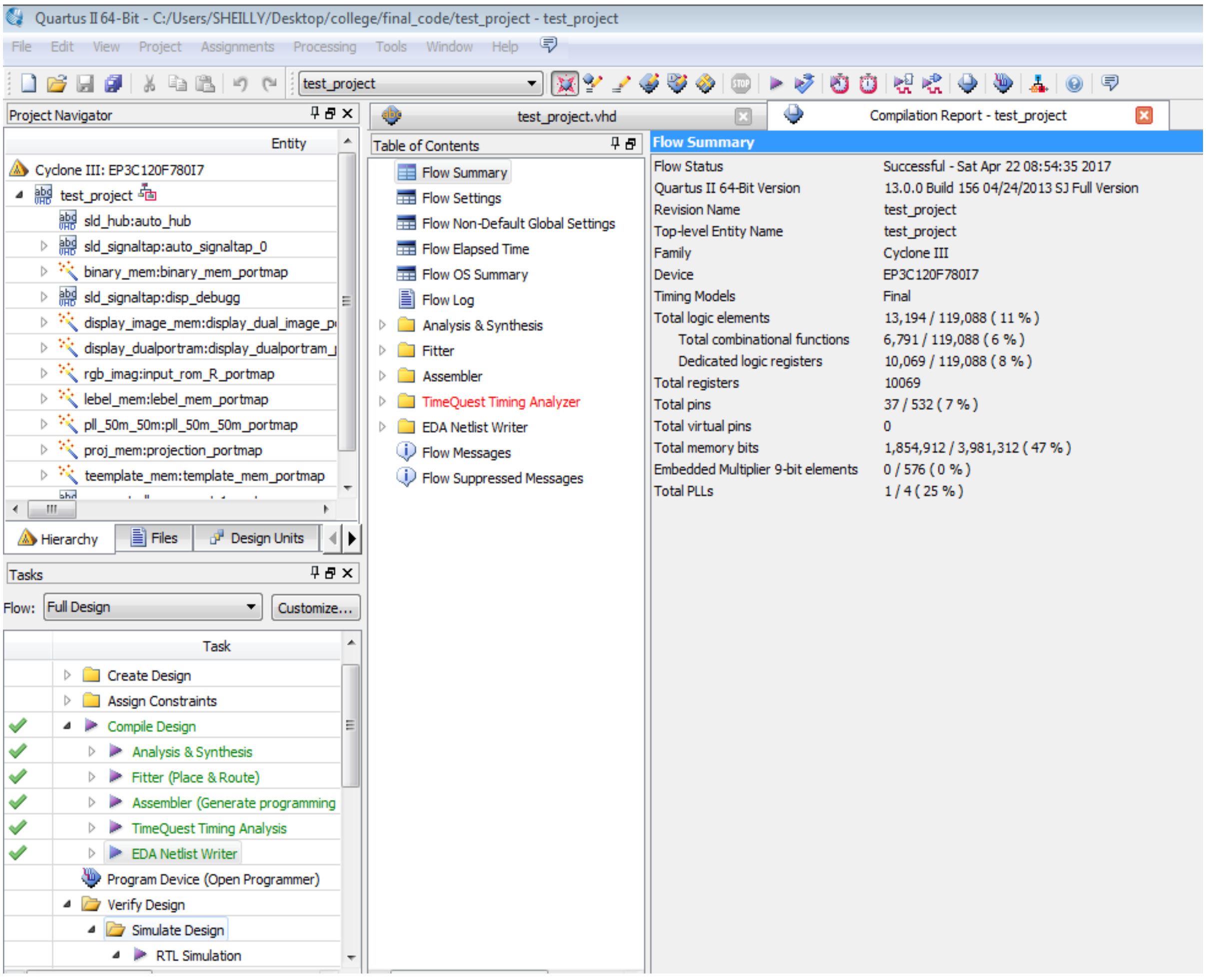

Figure 5.10 Design flow summary

Figure 5.11 depicts the address generation scheme for the considered input image. The pixel value corresponding to the row and column address is observed in the figure below.

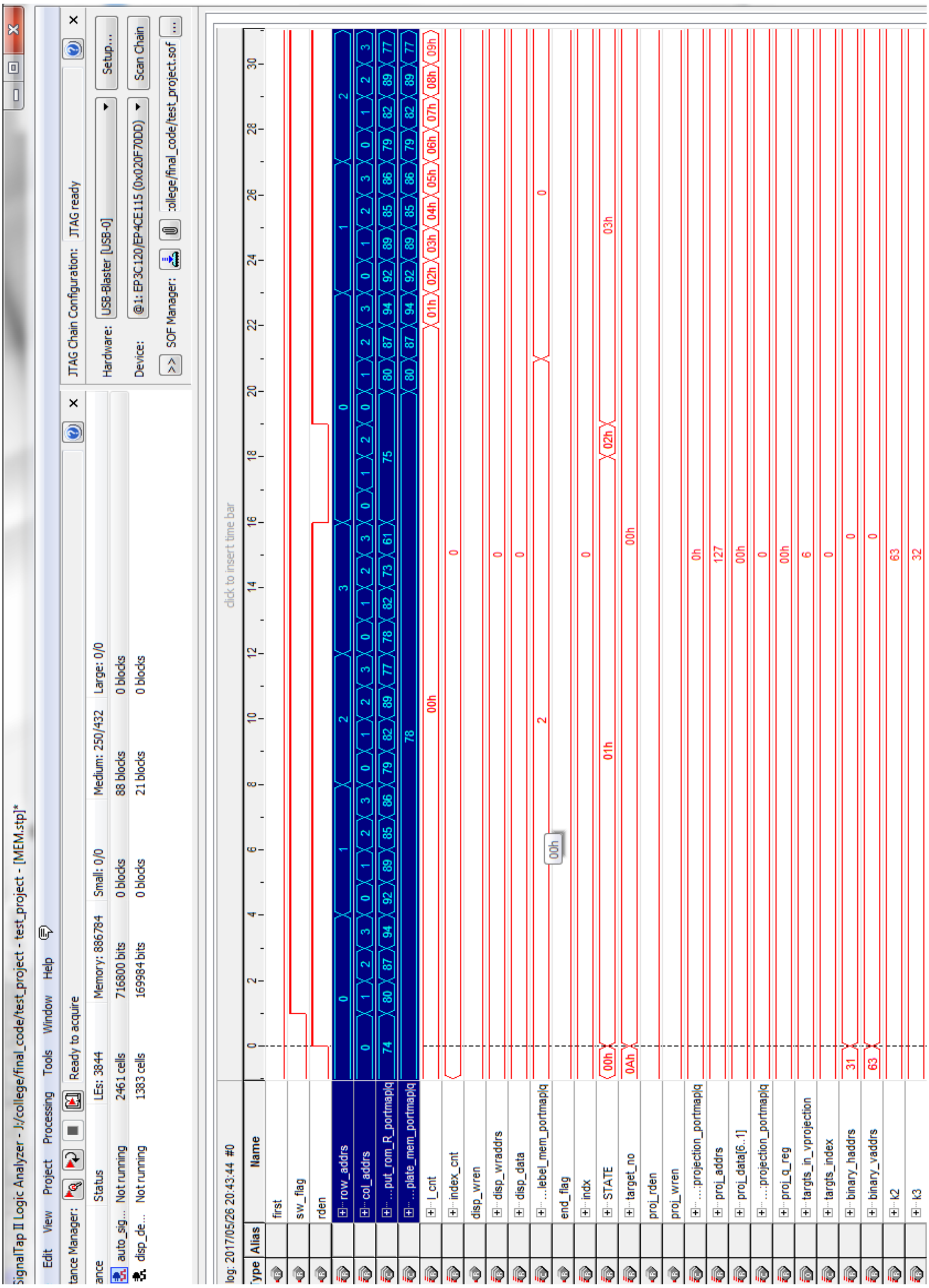

Figure 5.11 Address generation scheme for the image.

VHDL debugger result for block-wise segmentation is shown in Figure 5.12. The labels are obtained when read enable signal goes high. l_addrs in the figure represents the address location of the 4 x 4 block arranged in an array fashion. The label corresponding to the block is found after a single delay pulse.

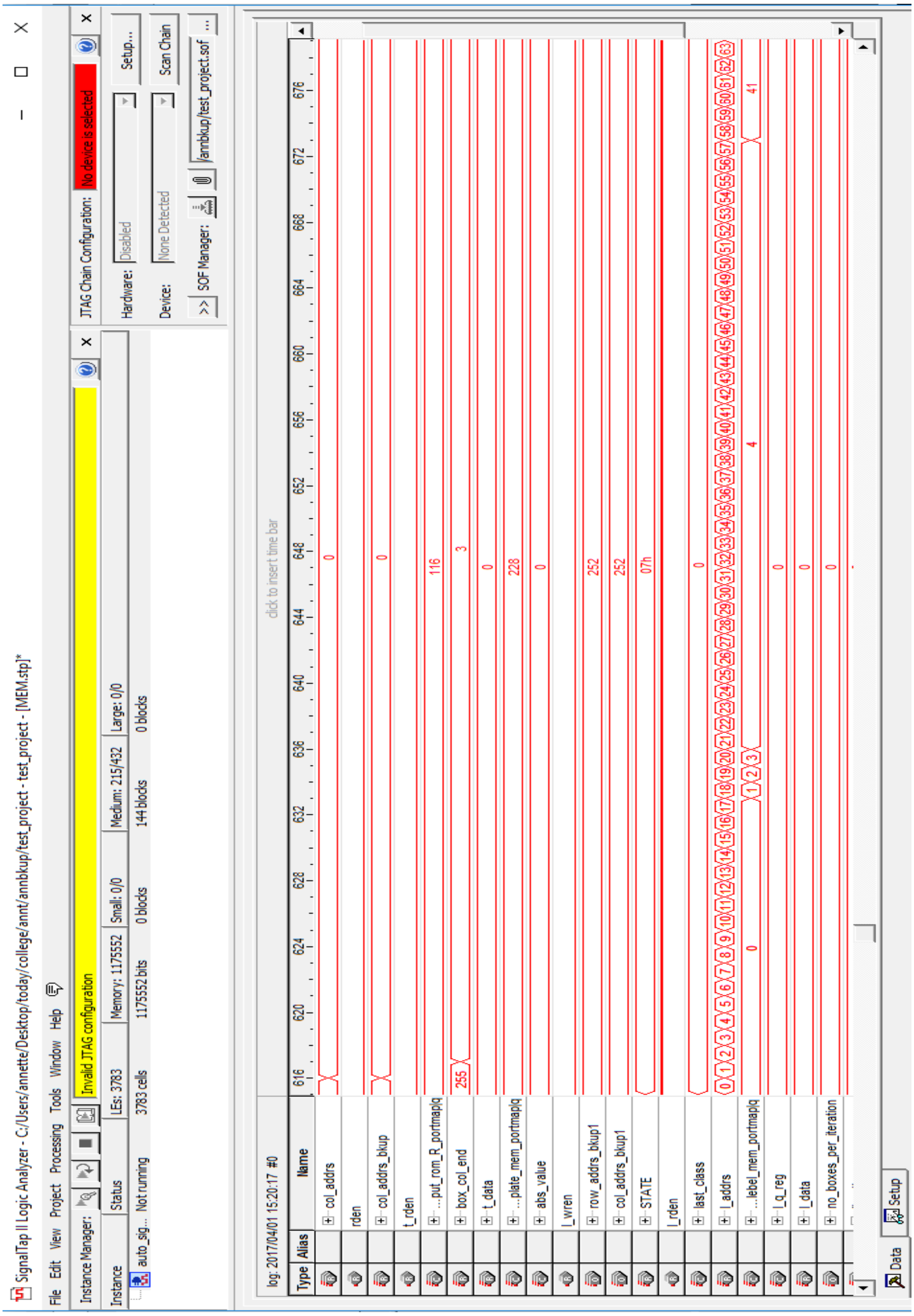

Figure 5.12 Debugger result of segmentation.

Figure 5.13 depicts the label count corresponding to the segmented labels ranging from 2 to 33. The count of label 3 is found to be highest and it represents the background blue in the segmentation output.

Figure 5.13 Label count corresponding to labels 2 to 33.

Figure 5.14 shows the label count corresponding to the segmented labels ranging from 28 to 59.

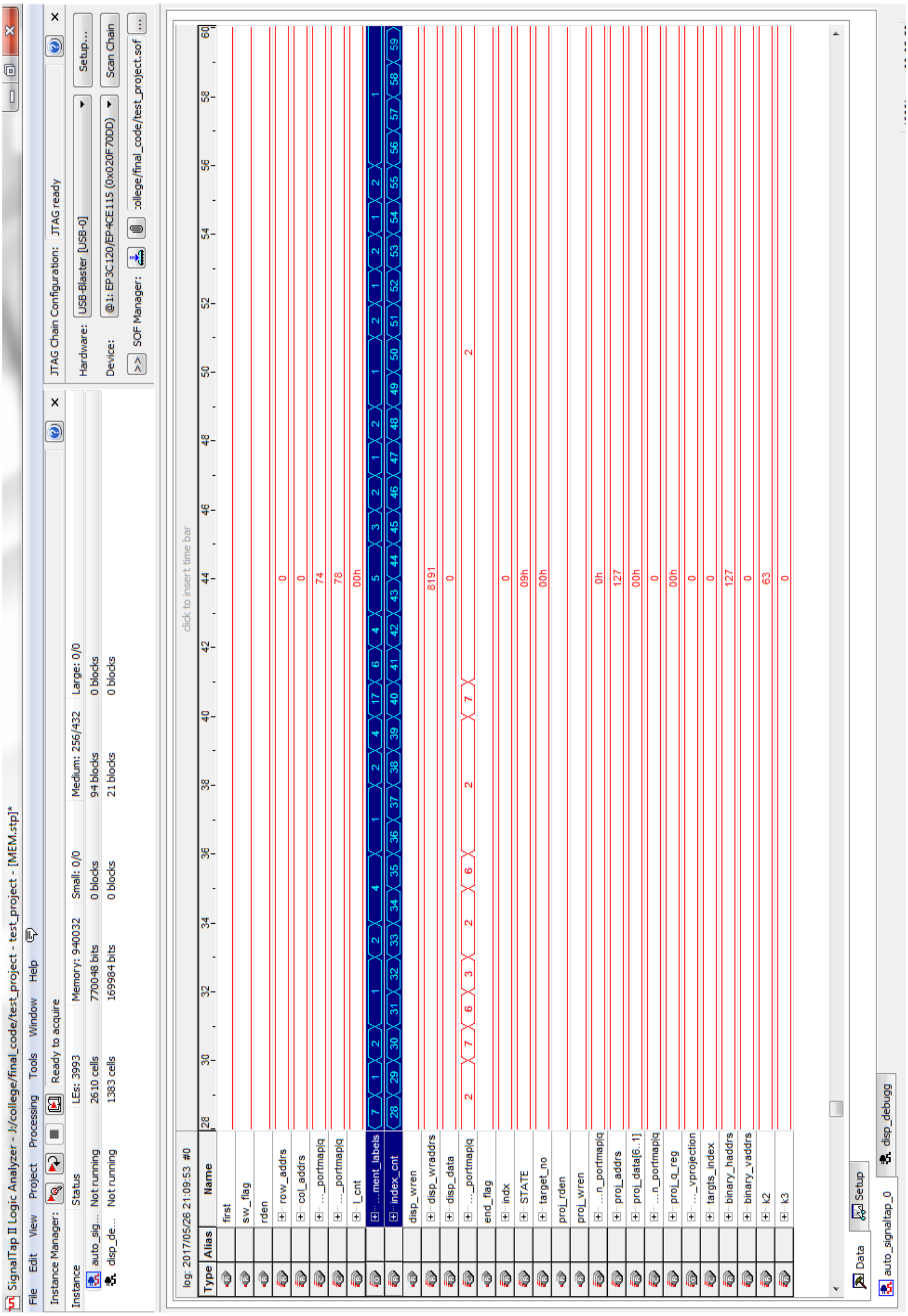

Figure 5.14 Label count corresponding to labels 28 to 59.

Figure 5.15 depicts the label count corresponding to the segmented labels ranging from 51 to 82.

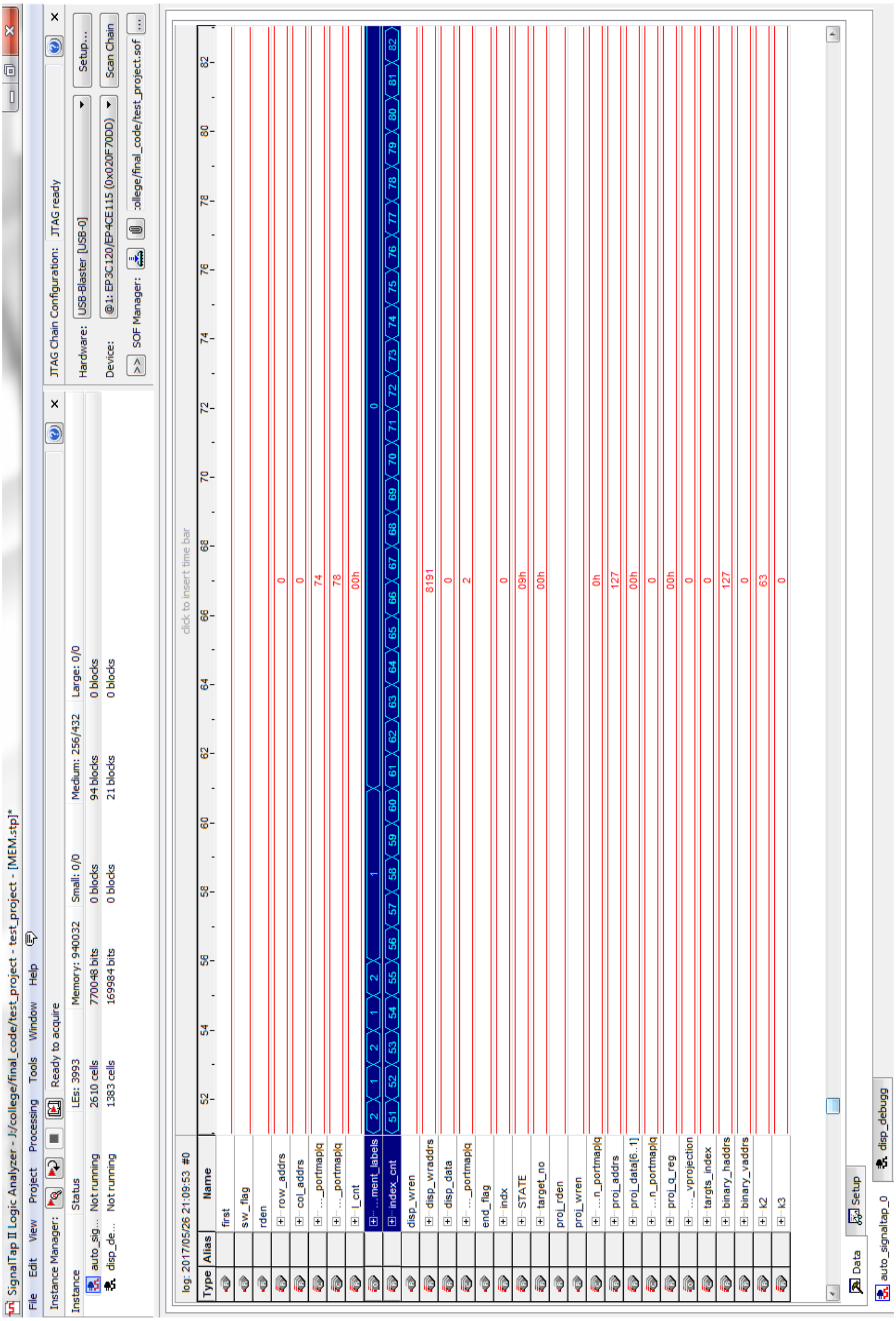

Figure 5.15 Label count corresponding to labels 51 to 82.

CHAPTER 6

CONCLUSION

The major contribution of this thesis is the histogram based image segmentation method to extract the targets in the satellite image. It is a unique approach to describe the region of an image that comprises of interested information. The algorithm introduced is automatic one and hence demands very little interactions. The important and key parameter of the work rely indefinitely on automatic thresholding algorithm. It is found that Kittler and Illingworth's thresholding algorithm provides a good automatic threshold value on the histogram considered and performs well on the image of interest. Since extraction is solely based on intensity, pixel intensities corresponding to regions which are identical to targets are also extracted. The ROI image thus obtained is analyzed with the template matched image to classify the targets. Template matching based on masks reduces the computation time. The efficiency of obtaining true targets from this proposed algorithm is seen to be highly effective. For real time applications, design is invoked on hardware. The results are obtained for image size of 256x256, but the approach discussed can be used for images of any size. ROI extraction based on segmentation is successfully implemented on customised board which uses Altera cyclone III FPGA. The future work is to implement the validation of targets using correlation method on the hardware.

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REFERENCES

[1] Tong Li, Jumping Zhang, Xiaochen Lu and Ye Zhang, SDBD: A hierarchial ROI detection approach in large scale remote sensing image, IEEE Geoscience and Remote Sensing Letters, Vol.14, Issue: 5, 2017, pp: 699-703.

[2] K Suresh Manic, R krishnapriya and V Rajnikanth, Image multithresholding based on Kapur's/Tsallis entropy and firefly algorithm, Indian journal of science and technology, Vol.9(12), ISSN:0974-5645, 2016.

[3] SenthilKumaran.N and Vaithegi.S, Image segmentation by using thresholding technique for medical images, International Journal in Computer Science and Communication Engineering, Vol.1, 2016.

[4] Zhongwen Hu, Qingquan Li, Qian Zhang and Guoseng Wu, Representation of block-based image feature in a multiscale framework for built up area detection, Journal on remote sensing and application, ISSN: 2072-4292, 2016.

[5] Warinthorn Kiadtikornthaweeyot and Adrian R.L. Tatnall, Region of Interest detection based on histogram segmentation for satellite image, The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol.XLI-B7, 2016, pp: 249-255.

[6] Amit Raikar P.G and Geeta Hanji, Automatic building detection from satellite images using internal gray variance and digital surface model, International Journal of Computer Applications, Vol.145, Issue:3, ISSN: 0975 – 8887, 2016.

[7] Paridhi Swaroop, Banasthali Vidhyapeeth and Neelam Sharma, An overview of various template matching methodologies in image processing, International Journal of Computer Applications, Vol.153, Issue: 10, ISSN: 0975 – 8887, 2016 .

[8] Aditya Rachman Patra, Fadhil Mochammad and Hans Heridan, FPGA implementation of template matching using binary sum of absolute difference, IEEE International Conference on System Engineering and Technology (ICSET), ISSN: 2470-640X, 2016.

[9] Animesh Chandra Roy, Muhammad Kamal Hossen and Debashis Nag, License plate detection and character recognition system for commercial vehicles based on morphological approach and template matching, IEEE

International Conference on Electrical Engineering and Information Communication Technology (ICEEICT), ISBN: 978-1-5090-2906-8, 2016.

[10] Yuri Marchetti Tavares, Nadia Nedjah and Luize de Macedo Mourelle, Hardware/software co-design system for template matching using particle swarm optimisation and pearson's correlation coefficient, IEEE Latin American Conference On Computational Intelligence (LA-CCI), ISBN: 978-1-5090-5105-2, 2016.

[11] Adriana Romero, Carlo Gatta and Gustau Camps, Unsupervised deep feature extraction for remote sensing image classification, IEEE Transactions on Geosciences and Remote Sensing, Vol.54, Issue: 3, ISSN: 1558-0644, 2015, pp: 1349-1362.

[12] Girish Kumar Tanwar and Shiv Kumar, Analysis of template matching method using correlation score, International Journal of Engineering and Technical Research, Vol.3, Issue: 12, ISSN: 2321-0869, 2015.

[13] Aarti Sharma, Automatic vehicle detection using various object detecting algorithm and thresholding methods, International Journal on Future Revolution in Computer Science and Communication Engineering, Vol.1, Issue: 1, 2015, pp:16 – 28.

[14] Hassan Id Ben Idder and Nabil Laachfoubi, Unsupervised multi-level thresholding method for weather satellite cloud segmentation, International Journal of Computer Applications, Vol.118, ISSN: 0975-8887, 2015.

[15] K. Sankar and Dr. M. Prabakaran, An efficient template matching algorithm for lung cancer detection using multi-resolution histogram based image segmentation, International Journal of Enhanced Research in Science Technology and Engineering, Vol.3, Issue: 1, ISSN: 2319-7463, 2014, pp:71-75.

[16] A. Atchaya, V. Rajinikanth and J.P. Aashiha, Gray-level histogram based multilevel threshold selection with bat algorithm, International Journal of Computer Applications, Vol.93, Issue: 16, ISSN: 0975 – 8887, 2014.

[17] Lizy Abraham and M. Sasikumar, Vehicle detection and classification from high resolution satellite images, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol.II-1, 2014.

[18] Y. Raghavender Rao, Nikhil Prathapani and E. Nagabhooshanam, Application of normalized cross correlation to image registration,

International Journal of Research in Engineering and Technology, Vol.3, Issue: 5, ISSN: 2321-7308, 2014.

[19] K. Bhargavi and S. Jyothi, A survey on threshold based segmentation technique in image processing, International Journal of Innovative Research and Development, Vol. 3, Issue: 12, ISSN 2278 – 0211, 2014, pp: 234-238.

[20] Gururaj Banakar and Ravikumar.A.V, Real time object visual inspection based on template matching using FPGA, International Journal of Scientific and Engineering Research, Vol.4, Issue: 8, ISSN: 2229-5518, 2013.

[21] Shilpa Kamdi and R.K.Krishna, Image segmentation and region growing algorithm, International Journal of Computer Technology and Electronics Engineering (IJCTEE), Vol. 2, Issue: 1, ISSN: 2249-6343, 2013.

[22] Noor A. Ibraheem and Rafiqul Z. Khan, Multiple Histogram technique for robust skin color based segmentation, American Journal of Engineering Research, Vol.2, Issue: 5, ISSN: 2320-0847, 2013, pp: 50-54.

[23] P. Daniel Ratna Raju and G. Neelima, Image segmentation by using histogram thresholding, IJCSET, Vol. 2, Issue: 1, ISSN: 2231-0711, 2012, pp: 776-779.

[24] R. C. Gonzalez and R. E. Woods, Digital Image Processing, 3 Edition, 2008.

[25] N. Nacereddine, L. Hamami, M. Tridi and N. Oucief, Non-Parametric histogram-based thresholding methods for weld defect detection in radiography, World Academy of Science, Engineering and Technology, 2007.

[26] http://www.satimagingcorp.com/gallery/

[27] http://www.altera.com/products/software/sysgen/app_docs/user_guide.htm

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ANNEXURE A

Technical Paper

Annette Nayana Palanna and Dr. Veena Devi Shastrimath V., "**Target Detection in Satellite Images**", is presented and published in 7th International Conference on Emerging Trends in Engineering (ICETE 2017) held on 12th May 2017 at N.M.A.M. Institute of Technology, Nitte, India.

ANNEXURE B

This section includes the datasheet details regarding the Altera cyclone III FPGA.

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Karnataka, India

2017 ICETE

Nitte, Karnataka

CERTIFICATE

This is to Certify that

Annette Nayana Palanna

Presented a Paper entitled

Target Detection in Satellite Images

Authored by

Annette Nayana Palanna, Veenadevi Shastrimath V.

At 7th International Conference on Emerging Trends in Engineering (ICETE 2017)

Organized by NMAM Institute of Technology, Nitte

On 12th May 2017

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Target Detection in Satellite Images

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Abstract- **In this paper, a Block-based approach, i.e., rectangular regions with prefixed block size is used for segmenting a high-resolution satellite image by histogram thresholding. An unsupervised segmentation approach is employed to classify the pixels into homogenous objects and subsequent labels without prior knowledge. An optimal automatic thresholding method for the selection of threshold is proposed for segmentation. Morphological dilation is used for the creation of ROI mask image. To validate the presence of real targets in the ROI image, template matching is performed using the mask image. One of the prime solutions for matching two sub-images is the use of cross-correlation coefficient. In this paper, template matching phenomena is proposed based on correlation score. The experimental results are noted for satellite images pertaining to various military domains in MATLAB. The algorithm is able to perform segmentation and detection of ROI more effectively with less missed targets.**

Keyword- **Histogram threshold, unsupervised segmentation, correlation score.**

I. INTRODUCTION

Satellite images are rich in providing geographical information. Therefore, there is a strong requirement of powerful and streamlined mechanisms to extract and explicate valuable information from massive satellite images for military applications. The satellite image contains various features, textures and shadows and it can be very hard to detect the region of interest (ROI). Therefore, segmentation is performed on an image. Segmentation of an image is the operation of assigning a label to every block in an image such that blocks with an identical label share certain visual characteristics [1]. Thus, covering the whole image or a set of contours extracted from the image. Unsupervised segmentation and classification of interested targets from satellite images is one of the most studied and demanding field in military applications. The pixels with constant window size in the image are separated into the different groups according to the intensity of the pixel and thus assigned with different labels [7]. Thresholding is one of the convenient techniques to perform segmentation on the basis of different intensities or colors in the foreground and background regions of an image [5]. The approach is based on the assumptions that object and background pixels in the image can be distinguished by their gray level threshold. Histogram thresholding is one of the inexpensive and swift techniques for unsupervised image classification [2]. The concept of histogram segmentation is to classify an image using an optimal threshold value. To achieve this, a non-parametric approach such as minimum error criterion is employed.

It is necessary to define a similarity measure between two or more different objects or images in many image analysis problems. Template matching is a classic and elementary method used to calculate similarities between objects using certain algorithms. In object recognition or pattern matching applications, template window is slided pixel-by-pixel basis in a large scene image and computes the correlation coefficient between them [4]. The highest value or peak of the correlation indicates the matches between a template and sub-images in the scene.

This paper proposes the use of unsupervised histogram segmentation technique to detect the ROI in the optical satellite image employed in military scenarios. Further template matching is performed to validate the presence of targets. The rest of the work is organized as follows: Section 2 presents the proposed system and the process of the model in detail. Section 3 demonstrates the experiment and results. The final section gives a conclusion of the work.

II. PROPOSED WORK

Spatial resolution is a prime aspect to be considered while using the satellite images for target detection. The aim of the proposed work is to develop an efficient algorithm for automatic detection and classification of the targets from high-resolution satellite images. The overall system block diagram is shown in Figure 1.

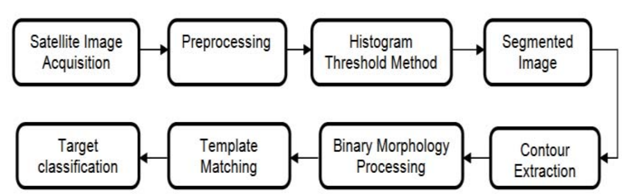


Fig.1. Block diagram of the proposed work.

A. Satellite Image Acquisition

The main two steps involved here are reading the raw satellite high resolution image in .jpeg format and resizing the image for further processing [5]. The importance of resizing the image will reduce the processing time.

B. Preprocessing

The second step involves conversion of color image into a grayscale image. However, some images collected by satellites have low signal-to-noise ratio [7]. In order to enhance the quality of images, they must be processed to reduce distortions or enhance some features required for further processing. Noise reduction or contrast enhancement techniques like histogram equalization and intensity adjustment techniques are of great interest in image analysis that improve image quality [6].

C. Histogram Threshold Method

The key parameter in the thresholding process is the selection of the threshold value. A new optimal threshold selection for image segmentation is found automatically by using Kittler and Illingworth Algorithm [8]. This minimum error thresholding method outperforms all the other existing methods like Otsu, Kapur thresholding etc., in their computational speed and also by defining fine and sparse details of the image under consideration [1].

In many practical applications, in an intensity image that is considered for target detection, foreground and background have different range of gray levels. Such images usually have a bimodal histogram.

The algorithm is as follows:

Step 1- Let us assume that pixels in the bimodal histogram of a gray-level image $h(g)$ is normally distributed. Normal distributions are defined by their means μ_i, standard deviations σ_i and a priori probabilities P_i .

Step 2- For a case of two different classes (i = $1, 2$) the background and foreground and given a threshold T, the parameters can be estimated from the following:

$$P_i(T) = \sum\nolimits_a^b h(g) \tag{1}$$

$$\mu_i(T) = \frac{1}{P_i(T)} \sum\nolimits_{g=a}^b h(g) g \tag{2}$$

$$\sigma_i^2(T) = \frac{1}{P_i(T)} \sum\nolimits_{g=a}^b h(g)(g - \mu_i(T))^2 \tag{3}$$

Where, $a = \begin{cases} 0 & i=1 \\ T+1 & i=2 \end{cases}$ and $b = \begin{cases} T & i=1 \\ n & i=2 \end{cases}$

Step 3- The criterion function is given by,

$$\begin{aligned} J(T) &= 1 + 2[P_1(T)\log\sigma_1(T) + P_2(T)\log\sigma_2(T)] \\ &- 2[P_1(T)\log P_1(T) + P_2(T)\log P_2(T)] \end{aligned} \tag{4}$$

Step 4- The minimum error threshold can be computed by minimizing the criterion $J(T)$.

D. Image Segmentation

The main focus of the approach discussed here is to partition the image into segments using intensity property of the pixels without prior knowledge of the classes [1-3]. An unsupervised approach employed here is by thresholding technique which uses membership criterion to segment the image satisfactorily.

The algorithm is explained briefly as follows:

Step 1- Select a Threshold (T) by Kittler's method.

Step 2- Select a block with measurement vector x_1.

Step 3- First block is taken as first cluster with center Z_1.

Step 4- Select next block from the image x_2.

Step 5- Compute the membership criterion defined by,

$$D_i(x) = \sum\nolimits_i^M \sum\nolimits_j^N |x_1 - x_2| \tag{5}$$

Where M x N is the size of the original image.

Step 6- Compare $D_i(x)$ with T. If $D_i(x) < T$, then assign appropriate label beginning from label1 else return to step 4 until all pixels are assigned to a class.

Step 7- After all pixels have been assigned to a cluster center, recompute $D_i(x)$ and assign the labels appropriately.

The final image is purely segmented with different labels associated with the image obtained.

E. Contour Extraction

The segmented image consists of numerous labels associated with various contour representations. In this step, the labels pertaining to large and small contours are nullified. The pseudo code for redefining the segmented label array in obtaining the labels of interest is mentioned below. The binary image pixels are reassigned with the intensity value '1' (white) if the pixels are in ROI areas, whereas other pixels are replaced with the value '0' (black) if they are categorized as the not interested area. Thus, this process gives contour image associated with several targets and less background details.

The Pseudo code is as follows:

```
for i ← 1: maximum of segmentlabelarray
labelcount ← find in segmentlabelarray
end for
// Removal of labels associated with minimum label count.
A = sort labelcount in descending order
for ii ← 1: minimum counted labels
segmentlabelarray(ii) ← 0
end for
// Removal of labels associated with maximum label count.
for iii ← 1: length of labelcount/2
segmentlabelarray(iii) ← 0
end for
```

F. Binary Morphology Processing

The binary contour image still contains many unwanted objects. In this paper, a parameter based on area of contours is used to remove contours larger than the template. Thus, a detailed contour image containing the ROI is obtained. This image is further subjected to Dilation to obtain the mask image [2]. Morphological Dilation enlarges the boundaries of the extracted contours (i.e. white pixels) on a binary image. The next step is to overlay the extracted targets onto the original image. Overlaying of the result helps to illustrate the accuracy of the target extraction. In order to accomplish this operation, rectangular bounding box based on the contours is drawn around the target in yellow color.

G. Template Matching

In this paper, Template Matching is based on normalized form of correlation (correlation coefficient) [4][6]. It will calculate the mean value of each image and then by calculating correlation score it will match the template image with source image.

The correlation coefficient (r) is given by,

$$r = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{\left(\sum_m \sum_n (A_{mn} - \bar{A})^2\right)\left(\sum_m \sum_n (B_{mn} - \bar{B})^2\right)}} \quad (6)$$

Where, A_{mn}= Source image of prefixed size m x n.
B_{mn}=Template image of prefixed size m x n.
$\bar{A}$ and $\bar{B}$= mean of Aand B respectively.

The algorithm is explained in the following steps below:
Step 1: Load Template Image with predefined window size.
Step 2: Load source Image.
Step 3: Load ROI Mask Image.
Step 4: Convert both Input images to gray image
Step 5: Find the mean and correlation coefficient values of template and source images of equal size.
Step 6: Check in entire binary mask image if Correlation coefficient value > 0.9. If so, then template is matched and target is confirmed.
Step 7: Draw Bounding Box around the target in red.

H. Target Classification

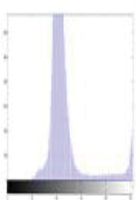
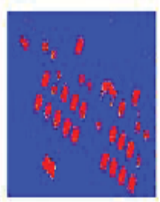
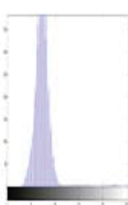
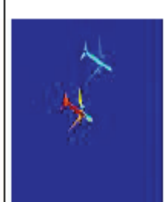
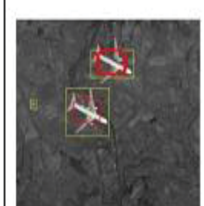
This is the last step of the proposed work, where the ROI image and the template matched images are compared [7]. If the targets present in both the images are same, then it is classified as true target. If any of the targets are missed in the ROI image they fall under missed target category. The rest of targets are classified under false target category. In addition, the efficiency of the true targets detected is computed.

III. EXPERIMENT RESULTS AND ANALYSIS

In this paper, performance of the proposed approach is evaluated with scenes obtained from Google Earth pertaining to military scenarios. Image 1 corresponds to satellite image of artillery battalion of Russian military; having size of 256 x 256 is used for the study. Two template images of size 16 x 24 and 17 x 10 corresponding to two different army camps are used for template matching purpose. Image 2 corresponds to satellite image covering a Russian military aircraft having size of 444 x 352 is used to demonstrate the performance over a vast land area. Template image of size 32 x 32 is used for template matching purpose. Table I shows the intermediate results used to extract targets of the corresponding input images. It is observed that, most of the manmade structure boundaries are detected. Thus, a qualitative analysis of the results shows that the proposed algorithm is successful in extracting the targets with reduced false alarms. The CPU time as tabulated in table II is solely based on the image size under consideration.

The segmented images are evaluated using the performance measure -Region Non-Uniformity (NU) [8]. This measure is defined as

TABLE I
EXPERIMENTAL RESULTS FOR TARGET EXTRACTION

	Original Image	Histogram Image	Segmented Image	ROI Image	Mask image	Template Image	Target classified Image
Image 1							
Image 2							

$$NU = \frac{|F_{fg}|}{|F_{fg} + B_{bg}|} \frac{\sigma_{fg}^2}{\sigma^2} \quad (7)$$

Where, σ^2 is the variance of the whole image.

σ_{fg}^2 is the foreground variance.

A well-segmented image is expected to have a NU measure close to 0. Table II shows NU measure for images under consideration. It is found that NU for Image1 is closer to zero. Hence a better segmented image compared to Image2.

The quality of segmented image is measured by statistical parameter- Peak Signal to Noise Ratio (PSNR) [1]. It is defined as,

$$PSNR = 10\log_{10}(MAX_i^2 / MSE) \quad (8)$$

Where, MAX_i is the maximum pixel value of the image.

MSE (Mean Squared Error) is the cumulative squared error between the segmented and the original image.

Finally, the accuracy of the true targets detected by the proposed method is calculated. Here, the results are compared with the ground truth derived manually.

$$Accuracy = \frac{EV}{OV} \times 100 \quad (9)$$

Where, EV is the Exact Value detected manually from ground truth image.

OV is the Obtained Value after applying the designed methodology.

The accuracy of detecting true targets from the proposed approach is high as shown in through the results tabulated in Table II. It is observed that, accuracy is lower for images having lesser targets when compared to images with more number of targets.

TABLE II
PERFORMANCE MEASURES FOR THE IMAGES UNDER CONSIDERATION

Images	T	NU	PSNR	CPU time(s)	EV	OV	Accuracy
Image 1	152	0.0056	0.2607	22	30	34	88.2
Image 2	116	0.0839	0.3741	107	2	3	66.3

I. CONCLUSION

The main contribution of this paper is the histogram based unsupervised image segmentation technique to extract the objects of interest in the satellite image by using ROI automatic detection. The ROI automatic detection is a novel approach to define the area of an image that contains information of interest. The algorithm introduced is automatic one. It requires only very little interaction from the users. It is observed that there is no perfect method for segmentation because the result of image segmentation depends on many factors i.e., pixel color, texture, intensity, similarity of images, image content and problem domain.

The important and key parameter of this algorithm is based on automatic thresholding algorithm. It is found that Kittler and Illingworth's thresholding algorithm provides a good automatic threshold. Thus, segmenting the image with less NU value.

The study focuses on extracting the ROI from satellite images purely concerning to military applications. This algorithm can be employed to extract different types of targets based on the application. Since extraction of targets discussed in this paper is solely based on intensity, some of the regions similar to the targets are also being extracted. This is because the locations also have the same pixel intensity values as that of targets. The algorithm is found to perform segmentation and detection of ROI more effectively with less missed targets. In addition, template matching based on masks reduces the computation time. The accuracy of obtaining true targets from target classified image by this proposed algorithm is seen to be highly effective.

II. REFERENCES

[1] K.Suresh Manic, R.KrishnaPriya and V.Rajnikanth, "Image multithresholding based on kapur/tsallis entropy and firefly algorithm," *Indian Journal of Science and Technology*, vol.9(12), ISSN:0974-5645, 2016.

[2] Warinthorn Kiadtikornthaweeyot, Adrian R.L. Tatnall, "Region of Interest detection based on Histogram segmentation for satellite image," *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, vol.XLI-B7, pp: 249-255, 2016.

[3] Zhongwen Hu, Qingquan Li, Qian Zhang and Guoseng Wu, "Representation of block-based image feature in a multi-scale framework for built up area detection," *Journal on Remote Sensing and Application*, vol.8, pp:1-20,2016.

[4] Girish Kumar Tanwar, Shiv Kumar, "Analysis of Template matching method using correlation score," *International Journal of Engineering and Technical Research*, ISSN: 2321-0869, vol.3, Issue 12, 2015.

[5] Aarti Sharma, "Automatic vehicle detection using various object detecting algorithm and thresholding methods, "*International Journal on Future Revolution in Computer Science and Communication Engineering*, vol.1, Issue 1, pp: 16 – 28, 2015.

[6] K.Sankar, Dr. M. Prabakaran, "An efficient template matching algorithm for lung cancer detection using multi resolution histogram based image segmentation," *International Journal of Enhanced Research in Science Technology and Engineering*, vol.3, Issue 1, pp:71-75, ISSN: 2319-7463, 2014.

[7] Lizy Abraham and M.Sasikumar, "Vehicle detection and classification from high resolution satellite images, "*ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, vol.II-1,pp:17-20,2014.

[8] T. Kalaiselvi and P. Nagaraja, "A robust Thresholding technique for image segmentation from gray images," *Proceedings of the International Conference on Applied Mathematics and Theoretical Computer Science,* pp: 183-188, ISBN: 978-93-82338-35-2, 2013.

Target detection in Satellite Images

by Annette 4nm15lvs01

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CHAPTER 1

INTRODUCTION

Satellite images are rich in providing geographical information. Therefore, there is a strong requirement of powerful and streamlined mechanisms to extract and explicate valuable information from massive satellite images for military applications. Segmentation is a method of allocating a label to every block in an image such that blocks with an identical label contribute to some common characteristics [1]. Thus, covering the whole image or contours extricated from image. There are plenty of manmade structures of interest such as buildings, vegetation areas or count of vehicles which are considered for the study from satellite or aerial images [5].

An existent scenario as seen from a satellite image comprises of various features, textures and shadows and it can therefore be very hard to find the ROI. The gripping part of a satellite image depends on the field of application employed for extraction of target [11]. There are numerous techniques to identify the clusters corresponding to ROI. Thus segmentation is focused for extracting different features or textures inside an image and is performed in numerous ways using the image properties.

Among many segmentation approaches existing in the literature, Thresholding is one of the convenient and favorable techniques employed with regard to intensities in an image. The application relies on the assumption that target and its background region in the image can be differentiated by their gray level threshold [2]. In this project, based on image histogram a threshold value is chosen automatically. The concept of histogram segmentation is to classify an image by an optimal threshold value. This is done by using Kittler's thresholding algorithm which automatically generates the threshold [20].

The main two types of classification techniques reported in the literature are supervised and unsupervised techniques [14]. Supervised classification focuses on training samples that are applied to classify the satellite image. In this project, unsupervised classification technique is employed owing to histogram segmentation. The pixels with constant window size are segregated into different groups in accordance with the pixel intensity and thus assigned with different labels [11]. The extent to which an image is segmented depends on the output that is demanded by the application. Therefore the conclusive way is to use a blend of different image processing methods to identify the interested areas.

Template Matching is a high level machine-vision technique that identifies a particular region of an image and matches to a prefixed template image. The highest value of correlation indicates that there is a match amongst the considered image patches. In general this method includes its unique algorithm to compare the chosen patch image with the source image and finds its similarity content [7].

The need to develop the algorithm in real time, leads to implementation in hardware, which supports parallelism, thus significantly reducing the processing time [7][8]. This project proposes the real time implementation of segmentation procedure to detect the ROI in the optical satellite image employed in military scenarios. The entire work is implemented in MATLAB and the output is verified with the very high speed integrated circuit hardware description language (VHDL) code required for hardware implementation.

1. 1 MOTIVATION

The extrication of ROI from an image is a thorough tough process using single image segmentation technique due to complexity level existing in the satellite images.

The extent to which an image is segmented depends on the output that is demanded by the application. Therefore the conclusive way is to use a blend of different image processing methods to identify the interested areas. The segmented image acquired by thresholding consumes lesser space for storage, rapid speed in processing and ease in manipulation, in comparison with a gray image containing 256 levels.

Target extraction approach makes use of captured information or footage which does not require any complex hardware thus making it inexpensive and easy to use. This thesis manifests a feasible solution for the segmentation problem. The initial process is determined by detecting the possible targets by segmentation from the image under consideration. Further using this output, classification of targets into true, missed or false estimation is carried out.

1.2 OBJECTIVE

The prime concern of this research lies in extricating targets from satellite or aerial images using block-based unsupervised segmentation method and validating the presence of targets using correlation coefficient.

1.3 PROBLEM DEFINITION

Target detection from optical satellite images play an important role in military and civil related domains and its drawback lies in its compromised interpretation under challenging flicker conditions. In this work, a novel automatic ROI finding technique is proposed to overcome this issue.

The objective of the thesis work is to detect and extract targets such as army camps, military bases, aircrafts etc from satellite or aerial images pertaining to military scenarios in real-time.

1.4 THESIS OUTLINE

This thesis is structured into 6 chapters.

Chapter 1 gives a brief introduction on ROI segmentation and Template matching. This chapter includes the motivation behind the research work, objective, and problem definition associated with the project.

Chapter 2 discusses the literature study relevant to the research work.

Chapter 3 discusses the proposed target extraction design methodology with a general block diagram with related expressions. The project discusses on segmentation to obtain the targets and hence validating the extracted targets using template matching phenomena.

Chapter 4 is about the software module description and a brief introduction related to hardware tool inclined in the research work.

Chapter 5 discusses the MATLAB results and simulation waveforms obtained for the proposed work.

Chapter 6 is about the conclusions deduced from the research work.

The last section lists the reference papers, journals, books and webpages that is referenced for the evolution of this project thesis.

CHAPTER 2

LITERATURE SURVEY

This survey includes numerous images, image segmentation, threshold techniques and previous work for detecting the ROI. A literature survey has been conducted to understand the current and past research trends in automated satellite imaging systems domain.

Tong et al., 2017 [1] describes the hierarchical saliency and density-based method for ROI extraction in large scale remote sensing images. In saliency-based method, multilevel histogram contrast is employed to suppress background details. To reduce the count of ROIs obtained, super-pixel segmentation is performed. Depending on the user selection of ROI to be extracted, density-based method on the basis of adaptive threshold and centroid selection is proposed. Higher accuracy was achieved for experiments conducted on extracting ROIs of tanks and residence from a large scale images.

A paper by K.Suresh et al., 2016 [2] describes a non-parametric technique to determine the global threshold. A detailed comparison based on Kapur/Tsallis function and Firefly algorithm is done considering the performance measure. The approaches are tested on Berkeley segmentation dataset. It is observed that entropy based algorithm gives good image quality measures.

Zhongwen et al., 2016 [4] introduced a block-based supervised segmentation approach for urban area detection from high-resolution optical and SAR images. Several features are extracted from each block of image. K-means clustering technique is used for segmentation purpose. Targets are choosen by thresholding. Experiments are conducted to extract buildings from SAR images of different resolutions and hence proving the robustness of the proposed technique.

A paper by Warinthorn et al., 2016 [5] proposes methods to segregate the targets in the satellite image using ROI extraction scheme. The author uses histogram segmentation to obtain the targets. The major drawback of this approach is manual threshold selection. Hence the proposed approach implements automatic threshold selection from the content of the histogram and identifies interested targets in image. The block-based approach has advantages in interpreting built-up areas when compared to the traditional pixel and object-based approaches.

A paper by Amit et al., 2016 [6] attempted to present automated technique to accurately identify the building from remotely sensed high resolution panchromatic images. To improve the contrast of the buildings, image enhancement technique is employed. Further, internal gray variance method and digital surface model technique is considered to extract the homogenous buildings by extracting its corner points. Image segmentation is done by non-parametric approach. The result concludes that the proposed technique is very precise and effective in comparison with other algorithms reported in the literature.

Aditya et al., 2016 [8] introduced hardware implementation of template matching phenomena using binary sum of absolute difference method on satellite images. The entire algorithm was designed to match 40x40 pixels at once. The design is tested on Altera Quartus II simulator and implemented on Altera DE2 development board having clock frequency of 50 MHz.

A paper by Yuri et al., 2016 [10] proposed co-design approach, where the correlation coefficient computation is implemented in hardware and Particle Swarm Optimization process in software. Thus this system can be used for real-time execution for pattern tracking. The major concern of the author is to develop portable devices for real-time applications. One major drawback lies in the pixel-wise computation of correlation coefficient. The overall processing time for the images is found to be high when compared to the software only implementation.

A paper by Aarti Sharma, 2015 [13] focuses on automatic vehicle detection using various object detecting algorithm and thresholding methods.Vehicle detection from satellite image is developed using morphological recognition algorithm in MATLAB and this thesis compares two thresholding techniques like pixel thresholding and Otsu thresholding method to get the best result. The result concludes that pixel level thresholding is better than Otsu method. Here image complementation are not used which make system more powerful and make system highly applicable. The result concluded that pixel level thresholding or block based thresholding is better than Otsu method for detecting the vehicles from satellite imaginary.

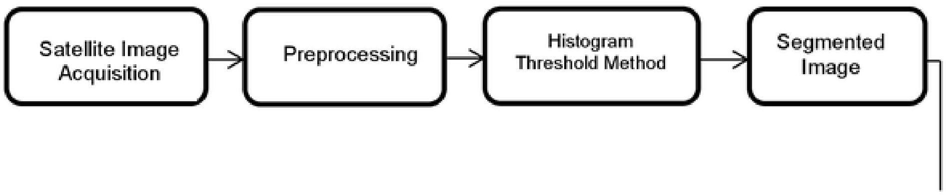
CHAPTER 3

PROPOSED WORK

3.1 OVERVIEW

Spatial resolution is a prime feature to be taken in to account for target detection in satellite images. Images with high spatial resolution are considered for the study which provides detailed information of an area. The aim of the proposed system is to arise with a robust algorithm for automatic detection and classification of the targets from high-resolution satellite images in real-time.

The block diagram of the proposed system is shown in Figure 3.1. It involves converting the original high resolution raw image into a grayscale image followed by some preprocessing techniques to remove the noise. The image pixel values are represented in terms of histograms. Histogram thresholding is the cheapest and fastest techniques for unsupervised image classification. The concept of histogram segmentation is to classify an image by a threshold value. This is done by using Kittler's thresholding algorithm which automatically decides the threshold and further performs unsupervised segmentation. Kittler's non-parametric method defines a criterion with regard to the assumption that the histograms of the changed and unchanged pixels are normally distributed and a threshold is selected by minimizing this criterion. The unsupervised approach attempts for classification without any prior knowledge from the user. Thus the segmented image consists of several labels, which in turn represents different associated regions. In binary image, targets are labeled as 1 and remaining labels are 0. There is a possibility of the existence of some unwanted pixels in the binary image which is removed using area criterion. Morphological dilation is performed on the binary image to get the mask image. Further with this mask, template matching is done to validate the presence of targets. Bounding box is put around the ROI. Only the proposed segmentation algorithm is converted to HDL code for the purpose of hardware implementation on Altera FPGA.



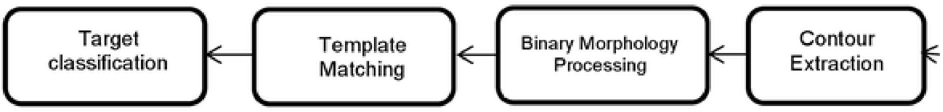


Figure 3.1 Proposed block diagram.

3.2 DESIGN STEPS

The main idea of our technique employs unsupervised segmentation method to classify the regions (labels) using automatic threshold. The final image will be composed of all the regions used for extraction of ROI from the original image.

3.2.1 Satellite Image Acquisition

The main two steps involved here are reading the raw satellite high resolution image in .jpeg format and resizing the image for further processing [5]. The importance of resizing the image will reduce the processing time [14].

3.2.2 Preprocessing

The second step involves conversion of color image into a grayscale image [16][17]. However, some images collected by satellites have low signal-to-noise ratio. In order to improve the quality of images, they must be processed to reduce distortions or enhance some features required for further processing. Noise reduction or contrast enhancement techniques like histogram equalization and intensity adjustment techniques are of great interest in image analysis that improve image quality [6].

3.2.2.1 Histogram Equalization

Histogram equalization is a technique to enhance contrast of an image by considering intensities [10]. Let *I* be an image represented as a $M \times N$ matrix of integer pixel intensities ranging from *0* to *L − 1*. Where *L* indicates the number of possible intensity values often 256. Let *N* be the normalized histogram of *I* with a bin for each possible intensity. So

$$N_n = \frac{\text{number of pixels with intensity n}}{\text{total number of pixels}} \qquad n = 0,1,\dots,L-1. \qquad \dots\dots \qquad (3.1)$$

The histogram equalized image g will be defined by

$$g_{i,j} = floor((L-1)\sum_{n=0}^{I_{i,j}} N_n) \qquad \dots\dots \qquad (3.2)$$

Where floor() rounds down to the nearest integer. This is equivalent to transforming the pixel intensities k of I by the function

$$T(k) = floor((L-1)\sum_{n=0}^{k} N_n) \quad \ldots\ldots \quad (3.3)$$

The transformation is by considering the intensities of I and g as continuous random variables X, Y on [0, L − 1] with Y defined by,

$$Y = T(X) = (L-1)\int_0^X N_X(x)dx \quad \ldots\ldots \quad (3.4)$$

Where N_X is the probability density function of I. T is the cumulative distributive function of X multiplied by (L − 1).

3.2.3 Histogram Threshold Method

The Histogram based threshold method considers histogram of an image as probability distribution and chooses a valley point as a final threshold value [19]. A new optimal threshold selection for image segmentation is found automatically by using Kittler and Illingworth Algorithm [12]. This is minimum error thresholding method, outperforming all the other existing methods like Otsu, Kapur thresholding etc., in their computational speed and also by defining fine and sparse details of the image under consideration by performing experiments on various military images.

In practical scenarios, images used for target detection contains two modes in their histogram [3]. Figure 3.2 shows a bimodal histogram for target and Non-target regions.

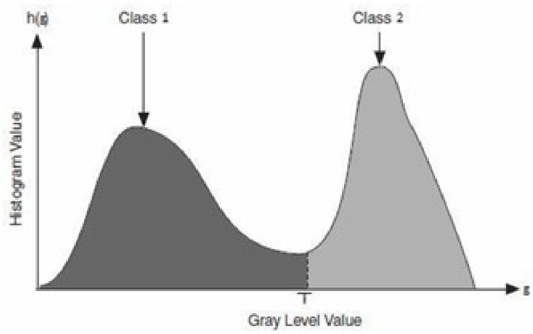


Figure 3.2 Bimodal histogram [3].

A grayscale image is a mix of white and black colors ranging from 0 to 255 intensity levels. Where 0 represents black color and 255 for white color. Depending on the location of targets on the grayscale histogram, threshold selection is divided into three categories. The three categories are

- Dark targets

- Medium gray targets
- Bright targets

For the image considered in Figure 3.3, it is observed that dark targets are found on brighter background and threshold obtained by Kittler's is 56. Figure 3.4 shows the histogram of the image. The pixel intensities below this threshold belong to target area or foreground and intensities above this threshold belong to the background area. Since the target lie in the first half of histogram, region greater than threshold is considered for segmentation.

Figure 3.3 Image of dark targets.

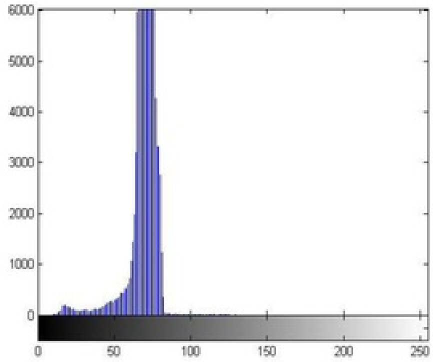
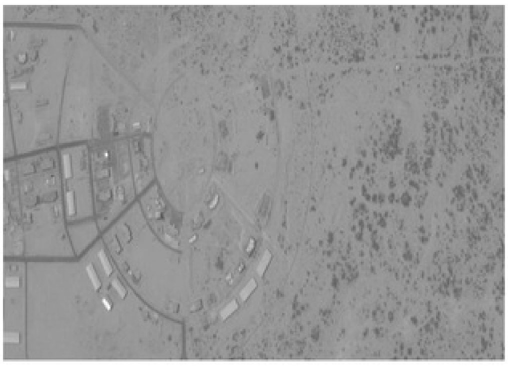


Figure 3.4 Histogram representation.

Figure 3.5 depicts the presence of medium gray shade targets on a similar shaded background. The histogram in Figure 3.6 shows that there is no much demarcation of targets from the background, making selection of threshold even more difficult. Hence histogram equalisation is performed on the image under consideration and is shown in Figure 3.7. The automatic threshold for the image is found to be 190. The equalised histogram of the image is shown in Figure 3.8. Since the target as seen from the equalized image is found to be brighter when compared to background, region less than the threshold are chosen for the study.



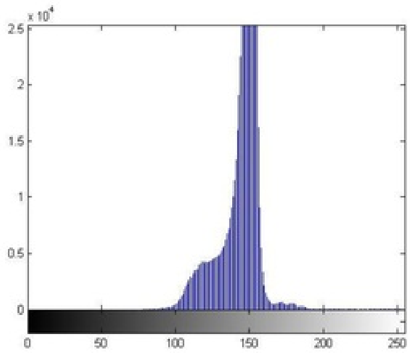


Figure 3.5 Image of medium gray targets.

Figure 3.6 Histogram of the image.

Figure 3.7 Histogram equalised image.

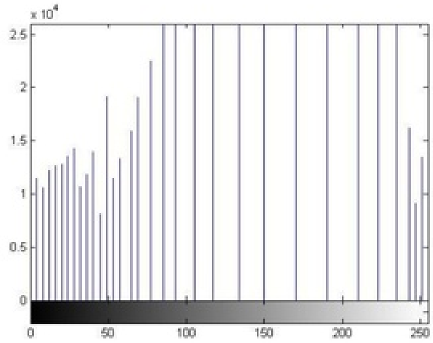


Figure 3.8 Equalized histogram.

Figure 3.9 shows image consisting of bright gray shaded targets on darker background. The histogram of the image is shown in Figure 3.10. It is noticed from the histogram that there is a clear cut separation between target and surroundings. The optimal threshold is found to be 120. Hence the pixels with intensities lesser than threshold is considered as the criterion for segmentation.

Figure 3.9 Image of bright targets.

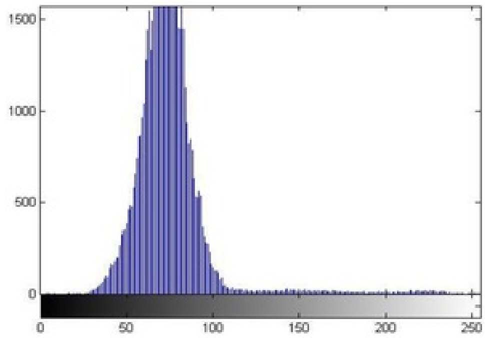


Figure 3.10 Histogram of the image.

The algorithm is as follows:

Step 1: Let us assume components of bimodal histogram in a gray-level image *h(g)* are normally distributed [23].

Step 2: For a case of two different classes (i = 1, 2) the background and foreground and given a threshold T, the parameters can be estimated from the following:

Priori probability, $P_i(T) = \sum_a^b h(g)$ …… (3.5)

$$\text{Mean, } \mu_i(T) = \frac{1}{P_i(T)} \sum_{g=a}^{b} h(g)g \qquad \ldots\ldots \qquad (3.6)$$

$$\text{Standard deviation, } \sigma_i^2(T) = \frac{1}{P_i(T)} \sum_{g=a}^{b} h(g)(g-\mu_i(T))^2 \qquad \ldots\ldots \qquad (3.7)$$

$$\text{Where, } a = \begin{cases} 0 & i = 1 \\ T+1 & i = 2 \end{cases} \text{ and } b = \begin{cases} T & i = 1 \\ n & i = 2 \end{cases}$$

n is the upper limit of the histogram.

Step 3: The criterion function is given by,

$$J(T) = 1 + 2[P_1(T)\log\sigma_1(T) + P_2(T)\log\sigma_2(T)] - 2[P_1(T)\log P_1(T) + P_2(T)\log P_2(T)] \qquad \ldots\ldots \qquad (3.8)$$

Step 4: The minimum error threshold can be computed by minimizing the criterion $J(T)$.

The advantage of this method is that only a single pass through the image is required. However, this method is dependent on the block size taken for scanning over the image.

3.2.4 Image Segmentation

Image segmentation is done using pixel intensity property of the pixels [5]. Thresholding techniques use intensity property of the pixels for segmenting the image. The block-based unsupervised clustering approach employed in this work is by kittler's non-parametric thresholding technique which uses membership criterion to segment the image satisfactorily, hence extracting the appropriate ROI [4][20][23][24].

The algorithm is explained briefly as follows:

Step 1: Select a Threshold (T) by Kittler's method.

Step 2: Select a block with measurement vector x_1.

Step 3: Let first block be taken as first cluster with center Z_1.

Step 4: Select next block from the image x_2.

Step 5: Compute the membership criterion defined by,

$$D_i(x) = \sum_i^M \sum_j^N |x_1 - x_2| \qquad \ldots\ldots \qquad (3.9)$$

Where, M x N is the size of the original image.

Step 6: Compare $D_i(x)$ with T. If $D_i(x) < T$ then assign appropriate label beginning from label1 else return to step 4 until all pixels are assigned to a class.

Step 7: After all pixels are assigned to a cluster center, recompute $D_i(x)$ and assign the labels appropriately.

The final image is purely segmented with different labels associated with the image obtained.

3.2.5 Contour Extraction

The segmented image consists of numerous labels associated with various contour representations. In this step, the labels pertaining to large and small contours are nullified. The pseudo code for redefining the segmented label array in obtaining the labels of interest is mentioned below. The ROI region in a binary image is assigned with value '1' (white) where as Non-ROI region with value '0' (black). Thus, this process gives contour image associated with several targets and less background details.

The Pseudo code is as follows:

$$
\begin{aligned}
&for\ i \leftarrow 1{:}\, maximum\ of\ segmentlabelarray\\
&labelcount \leftarrow find\ in\ segmentlabelarray\\
&end\ for\\
&//\ Removal\ of\ labels\ associated\ with\ minimum\ label\ count.\\
&A = sort\ labelcount\ in\ descending\ order\\
&for\ ii \leftarrow 1{:}\, minimum\ counted\ labels\\
&segmentlabelarray(ii) \leftarrow 0\\
&end\ for\\
&//\ Removal\ of\ labels\ associated\ with\ maximum\ label\ count.\\
&for\ iii \leftarrow 1{:}\, length\ of\ labelcount/2\\
&segmentlabelarray(iii) \leftarrow 0\\
&end\ for
\end{aligned}
$$

3.2.6 Binary Morphology Processing

The binary contour image contains many irrelavent objects. In this project, a parameter based on area of contours is considered to remove contours larger than the template [1][14]. Thus, a detailed contour image containing the ROI is obtained. This image is further subjected to Dilation to obtain the mask image. Morphological Dilation enlarges the boundaries of the extracted contours (i.e. white pixels) on a contour image [5][6]. The Dilation operator has two data inputs. The first one is the binary image which has to be dilated and the second one is the square structure element (kernel) of dimension 2 x 2.The next step is to overlay the targets on the original image. Overlaying the result helps to enhance the accuracy of the target extraction. In order to accomplish this operation, rectangular bounding box based on the contours is drawn around the target in yellow color.

3.2.7 Template Matching

In this project, Template Matching is based on normalized form of correlation (correlation coefficient) [12][20]. It will calculate the mean value of each image and then by calculating correlation score it will match the template image with source image [7]. The correlation coefficient (c) is given by,

$$c = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{\left(\sum_m \sum_n (A_{mn} - \bar{A})^2\right)\left(\sum_m \sum_n (B_{mn} - \bar{B})^2\right)}} \quad \ldots\ldots \quad (3.10)$$

Where, A_{mn} = Source image of prefixed size m x n.

B_{mn} =Template image of prefixed size m x n.

$\bar{A}$ and $\bar{B}$ = mean of A and B respectively.

The block diagram of correlation coefficient is given in Figure 3.11.

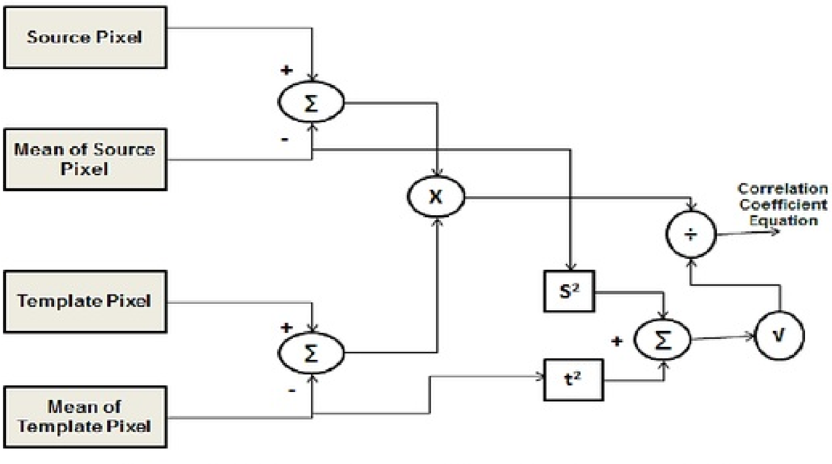


Figure 3.11 Correlation coefficient block diagram [12].

The algorithm is explained in the following steps below:

Step 1: Load Template Image with predefined window size.

Step 2: Load source Image.

Step 3: Load ROI Mask Image.

Step 4: Convert both Input images to gray image

Step 5: Find the mean and correlation coefficient values of template and source images of equal size.

Step 6: Check in entire binary mask image if Correlation coefficient value > 0.9. If so, then template is matched and target is confirmed.

Step 7: Draw Bounding Box around the target in red.

3.2.8 Target Classification

This is the last step of the proposed work, where the ROI image and the template matched images are compared [5]. If the targets present in both the images are same, then it is classified as true target. If the targets are missed in the ROI image they fall under missed target category. The rest are classified under false target category [9]. In addition, the efficiency of the true targets detected is computed.

CHAPTER 4

SOFTWARE AND HARDWARE REQUIREMENT

4.1 SOFTWARE TOOL

This section gives details regarding the softwares like MATLAB and VHDL used for coding in this work.

4.1.1 Introduction to MATLAB

MATLAB is user-friendly and highly suited for image processing scenarios. Particularly, MATLAB's matrix-oriented language includes built-in commands and math functions which is perfectly suited for manipulating images, implementation of algorithms, user interface, interfacing with high level languages, creation of models and many others. In addition, toolbox in MATLAB provides a flexible and powerful environment for image analysis and processing.

There are numerous benefits of using MATLAB for image analysis. It is possible to stop any calculation anytime with the help of this program, alter a part of the calculation process and then restart the calculations from where it was affected without recompiling the code which usually happens with programming in other languages.

4.1.2 Introduction to VHDL

VHDL is a hardware description language which is designed for characterising the behavior of digital systems. It allows electrical aspect of circuit behavior such as rise and fall times of signals, gate delays and functional operation to be described. The VHDL integrated development environment (IDE) supports hardware design for FPGA implementation of various companies such as Xilinx ISE, Altera Quartus, Synopsys Synplify or Mentor Graphics HDL Designer to produce the register transfer logic (RTL) schematic of the desired circuit. One of the prime applications of VHDL lies in capturing the performance of a circuit in the form of so called test bench. The inputs for a VHDL code or circuit have to be defined accurately for the creation of appropriate test bench.

4.2 HARDWARE TOOL

The Quartus II development software provides a complete design environment for system-on-a-programmable-chip (SOPC) design. The following section describes the design flow of the Quartus II software [27].

4.2.1 Quartus II design flow

The complete Quartus II system comprises of an IDE that includes every step from design entry to device programming.

The design flow is as follows:

Step 1: Setting up the design hierarchy for secure partitioning.

Step 2: Run analysis and elaboration.

Step 3: Create design partitions for secured regions.

Step 4: Create a design floorplan with security attributes.

Step 5: Assigning design partitions to secured regions.

Step 6: Add I/O pins as members of the secured region that sources or sinks the I/O pin.

Step 7: Create security routing interface regions.

Step 8: Make I/O assignments.

Step 9: Make design changes, set netlist type for each design partition and compile.

SignalTap II embedded logic analyser is a system level debugging tool that captures and displays signals in circuits designed for implementation in Altera's FPGAs. This tool allows to use an existing SignalTap II file (.stp) to run an analysis or to make any necessary alterations. According to the set up conditions, it is possible to capture the data when the SignalTap II logic analyser is triggered. The features of this tool are namely,

- It uses available internal memory.
- Incremental compilation support.
- Power-up trigger support.
- Megafunction support.
- Probes state of internal signals without using external equipment or extra I/O pins.

4.3 FPGA

4.3.1 Introduction to FPGA

Field Programmable Gate Array (FPGA) is one step ahead in the programmable logic devices. The word Field in the name refers to the ability of the gate arrays to be programmed for a specific function by the user instead of by the manufacturer of the device. The word Array indicates a series of columns and rows of gates that are programmed by the user. FPGA is an integrated silicon chip that can be programmed electrically to implement any digital design [8]. A single FPGA chip consists of millions of logic gates. When a FPGA is configured, the internal circuitry gets established in a way that creates software application to be implemented on hardware. The advantage of FPGAs when compared to processors is that it uses dedicated hardware for processing logic and do not have an operating system. FPGAs are highly parallel in its operation. Thus it provides adequate amount of resources for the operation which in turn enhances the throughput. The internal resources of an FPGA chip consist of a matrix of Configurable Logic Blocks (CLBs) surrounded by a periphery of I/O blocks shown in Figure 4.1. In addition, signals within the matrix of FPGA are routed via programmable interconnect switches and wire routes.

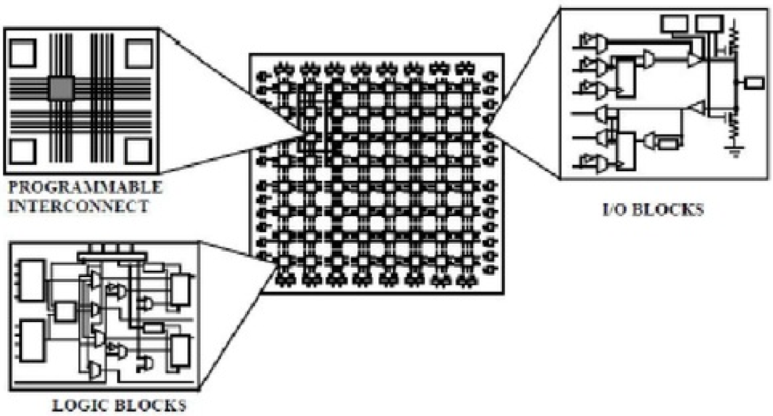


Figure 4.1 Internal structure of FPGA [20].

Logic blocks in an FPGA are implemented using multiple level low fan-in gates and provides a more compact design compared to other existing designs. Routing in FPGAs consists of wire segments of varying lengths which are interconnected via electrically programmable switches. The simplified version of FPGA internal architecture with routing is shown in Figure 4.2.

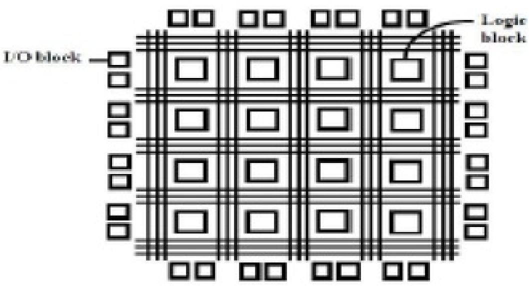


Figure 4.2 Simplified internal structure of FPGA [20].

4.3.2 ALTERA CYCLONE III

Cyclone III device family comprises of a customer-defined feature which is used for portable applications. It provides a good range of density, memory, embedded multiplier and I/O options.

The Cyclone III customised board is shown in Figure 4.3. The board details used in this project contains the following:

- EP3C120F780I7 Cyclone III device

- Two USB blaster connectors
- Euro connector of 96 pins
- Accessory daughter cards: Two loopback high-speed mezzanine connector
  (HSMC) cards and Debug HSMC card
- 5V DC Power supply
- PAL encoder
- Two 20-bit ADC
- DAC of 30 lines
- Four external memories- Synchronous burst SRAM.
- Six regulators
- 50Mhz crystal oscillator
- Two video jacks.

Figure 4.3 Cyclone III customised board

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 SIMULATION RESULTS

The proposed work is evaluated for a military image acquired from Google Earth. Image in Figure 5.1 corresponds to satellite image covering a Russian military aircraft having size of 444 x 352 is considered for demonstrating the performance over a vast land area.

Figure 5.1 Original image of military aircraft [26].

The huge image is resized to 256 x 256 to reduce computation time and for easier implementation on hardware. Further preprocessing technique is employed and is shown in Figure 5.2.

Figure 5.2 Resized grayscale image of military aircraft.

Figure 5.3 shows the histogram distribution for an image. The pixel values are more intense towards the left side of the histogram which represents the large darker shaded area of the image while right extreme end has lower intensity count representing the minimum bright regions in the image. Hence a well distinguished histogram. Since the targets belong to bright pixels in the histogram, it is necessary to use intensities lesser than threshold for the purpose of segmentation.

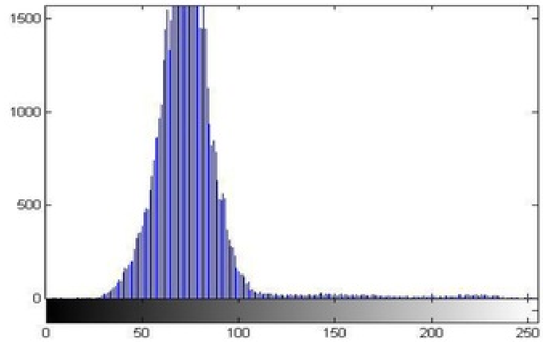


Figure 5.3 Histogram representation of the image.

The proposed non-parametric thresholding algorithm achieves the threshold of 120 from the histogram representation for the considered image. Hence the automatic threshold segments the image into several labels as shown in Figure 5.4, giving label count upto 82. The color blue represents the background and colors except blue represents foreground details.

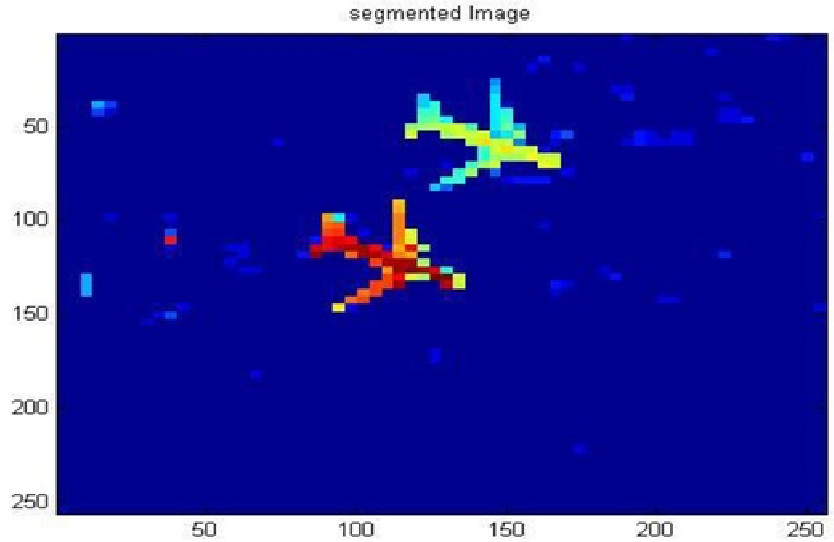


Figure 5.4 Unsupervised segmentation of the image.

The next step is to convert the segmented image into binary by removing the false contours. Hence the ROIs are labeled as 1 and Non-ROIs as label 0. Further reduction of irrelevant targets is achieved using area criterion. Since the targets are identical, common template area of 400 is used for the study. This image is subjected to dilation using square structuring element of size 2 x 2. Thus the mask image is generated. Figure 5.5 shows the mask image employed for template matching purpose.

Figure 5.5 Mask image.

Figure 5.6 displays the ROI segmented image achieved using unsupervised segmentation on the basis of membership criterion and threshold. It is noticed that there is one false alarm produced. This is proved to be false by template matching approach. The bounding box in yellow colour represents the targets obtained by segmentation approach.

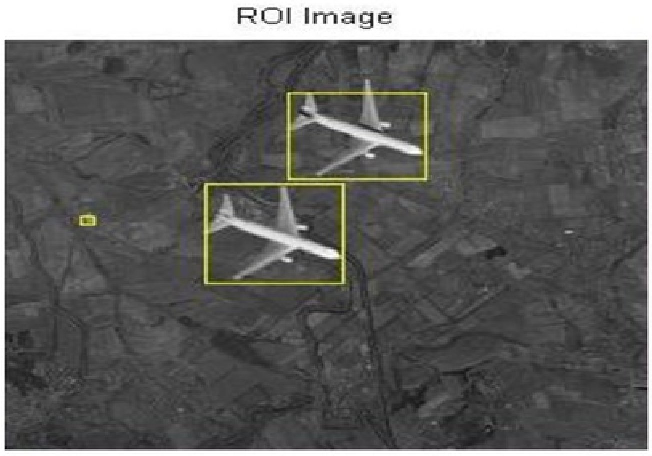


Figure 5.6 ROI segmented image.

Template image of size 20 x 20 is considered for template matching purpose. A common feature of aircrafts is that the shape and size of the similar aircrafts are identical. Thus a single template is taken in this study and is depicted in Figure 5.7. By considering the mask image, template matching is performed using correlation coefficient. Hence true targets obtained are represented in red bounding box as shown in Figure 5.8. The single ROI left out will be classified under false targets. It is noted that, there is no missed targets found in this considered image.

Figure 5.7 Template image.

Figure 5.8 Target classified image.

It is observed that, majority of the manmade structure boundaries are detected. Thus, a qualitative examination of the results shows that the proposed approach is successful in extracting the targets with reduced false alarms.

5.2 PERFORMANCE MEASURES

The performance of the proposed system is evaluated on the considered image for this research work. The CPU time as tabulated in Table 5.1 follows the image size under consideration.

The segmented image is evaluated using the behavior criteria - Region Non-Uniformity (NU) [20]. This measure is defined as

$$NU = \frac{|F_{fg}|}{|F_{fg} + B_{bg}|} \frac{\sigma_{fg}^2}{\sigma^2} \qquad \ldots\ldots \quad (5.1)$$

Where, σ^2 is the variance of the whole image.

σ_{fg}^2 is the foreground variance.

A well-segmented image is expected to pursue a NU measure close to 0. Table 5.1 shows NU measure for image under consideration. It is found that NU for Image is closer to zero. Hence a better segmented image.

The standard of segmented image is measured by analytical framework- Peak Signal to Noise Ratio (PSNR) [2][16]. It is defined as,

$$PSNR = 10\log_{10}(MAX_i^2 / MSE) \qquad \ldots\ldots \quad (5.2)$$

Where, MAX_i is the maximum pixel of the image.

MSE (Mean Squared Error) is the cumulative squared error between the segmented and the source image.

Finally, the accuracy of the true targets detected by the proposed approach is calculated. Here, the output is compared with the ground truth derived manually.

$$Accuracy = \frac{EV}{OV} \times 100 \qquad \ldots\ldots \quad (5.3)$$

Where, EV is the Exact Value obtained from manual count.

OV is the Obtained Value from the proposed algorithm.

The accuracy of detecting true targets from the proposed approach is high as shown in through the results tabulated in Table 5.1. It is observed that, accuracy is lower for images having lesser targets when compared to images with more number of targets.

TABLE 5.1

PERFORMANCE MEASURES FOR THE IMAGE UNDER CONSIDERATION

Images	T	NU	PSNR	CPU time(s)	EV	OV	Accuracy
Image	120	0.0839	0.3741	107	2	3	66.3

5.3 HARDWARE SETUP

In this experiment, the data width of both template and source images are same. The RGB image is transformed into grayscale on MATLAB and stored as a text file. This file in VHDL (.mif) is subjected for further processing. The basic requirements of the proposed system are specified in Table 5.2.

TABLE 5.2

SPECIFICATIONS OF THE PROPOSED DESIGN.

Target Image size	256 x 256 pixels
Template Image size	20 x 20 pixels

Search window size	4 x 4 pixels
System bus width	8- bit
Language	VHDL
Targeted platform	QUARTUS II
Target Device	Cyclone III
Configuration tool	USB blaster

The part of the proposed work is implemented on customized Altera cyclone III FPGA board. The design for ROI extraction is successfully implemented on VHDL. The general architecture of the hardware design is shown in Figure 5.9. In this context, single port RAM 1 is used to store the original image which is considered for algorithm processing. RAM 2 is the dual port RAM focused to store the intermediate results required for further processing. The result image is also stored in this RAM. Finally the output image is seen using the display.

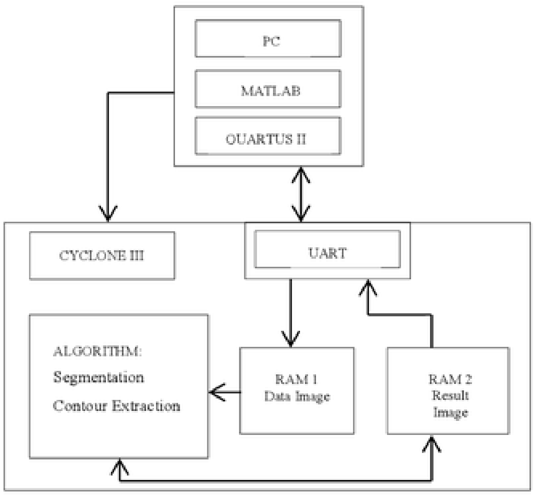


Figure 5.9 General architecture of the hardware design.

The resources utilized and the design flow summary of the generated code is shown in Figure 5.10

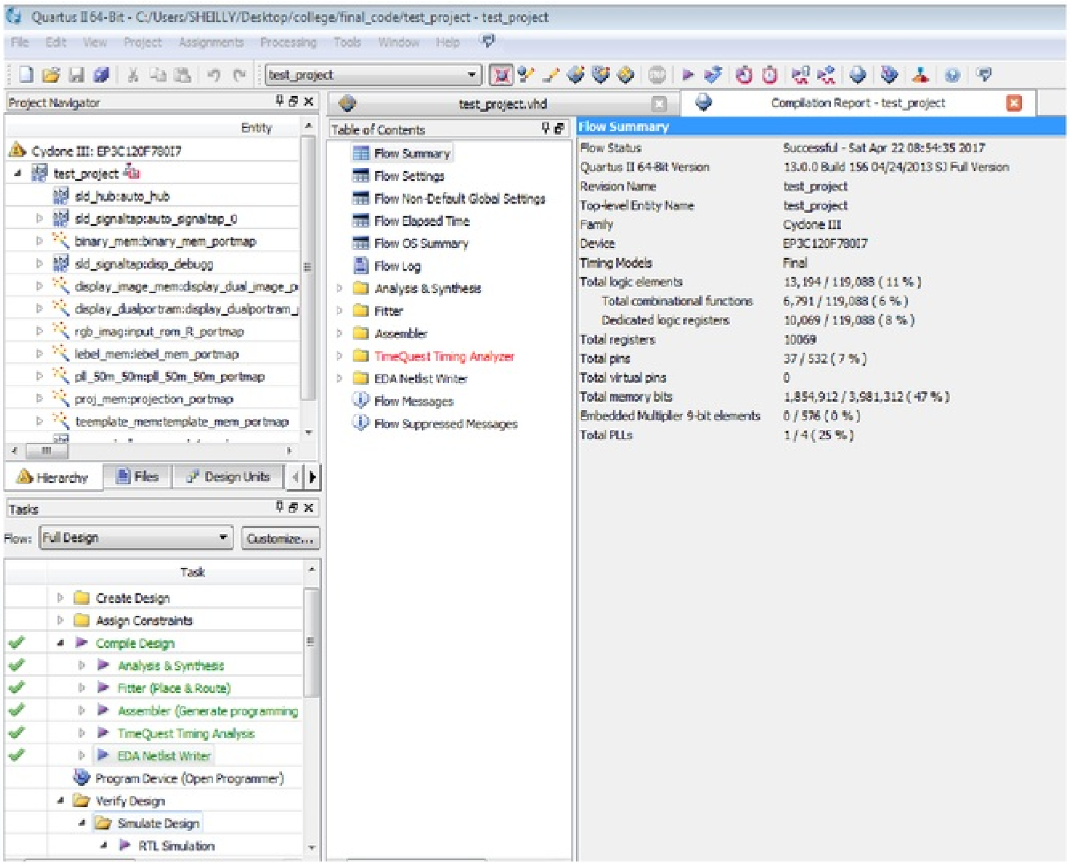


Figure 5.10 Design flow summary

Figure 5.11 depicts the address generation scheme for the considered input image. The pixel value corresponding to the row and column address is observed in the figure below.

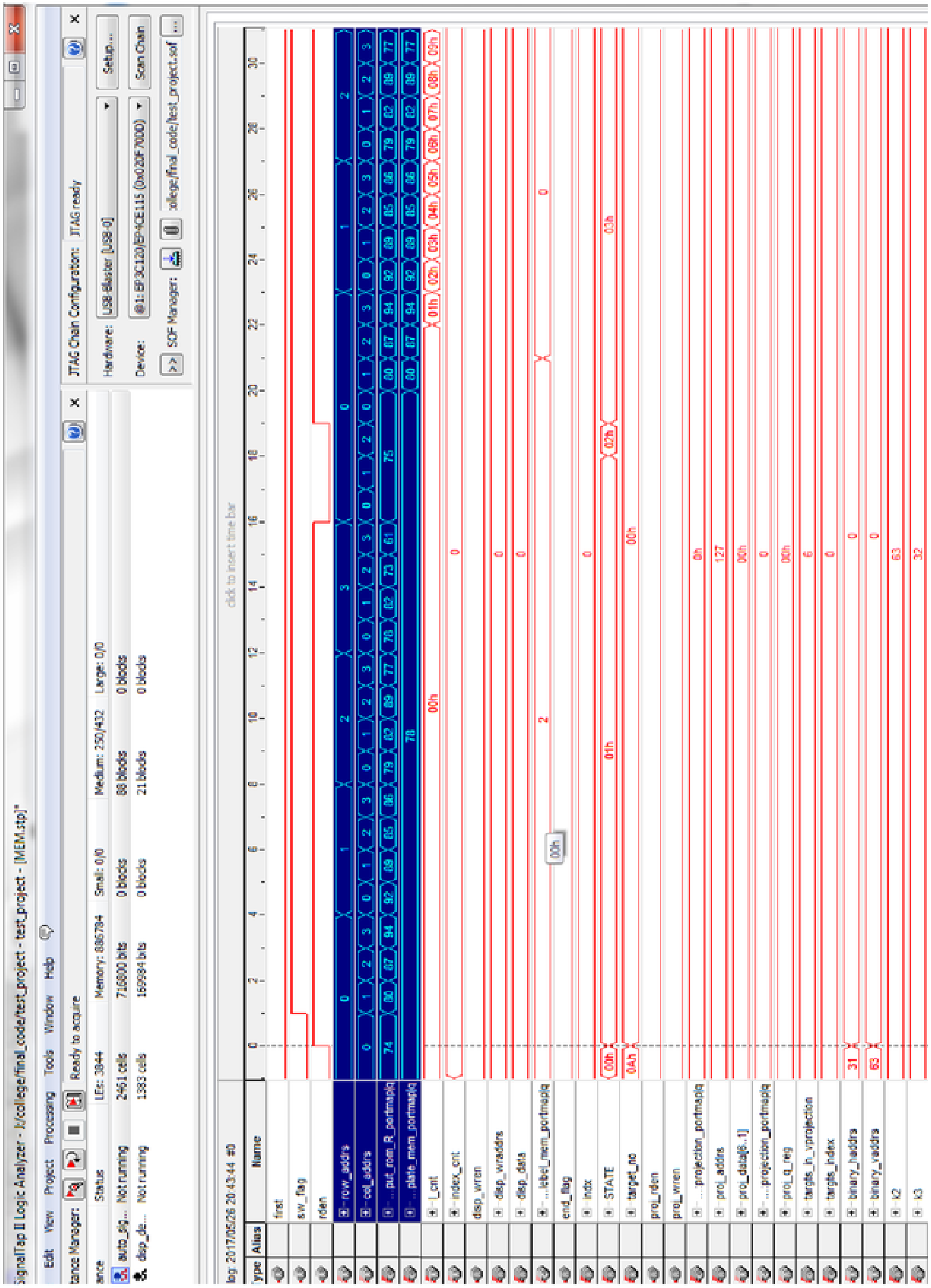


Figure 5.11 Address generation scheme for the image.

VHDL debugger result for block-wise segmentation is shown in Figure 5.12. The labels are obtained when read enable signal goes high. l_addrs in the figure represents the address location of the 4 x 4 block arranged in an array fashion. The label corresponding to the block is found after a single delay pulse.

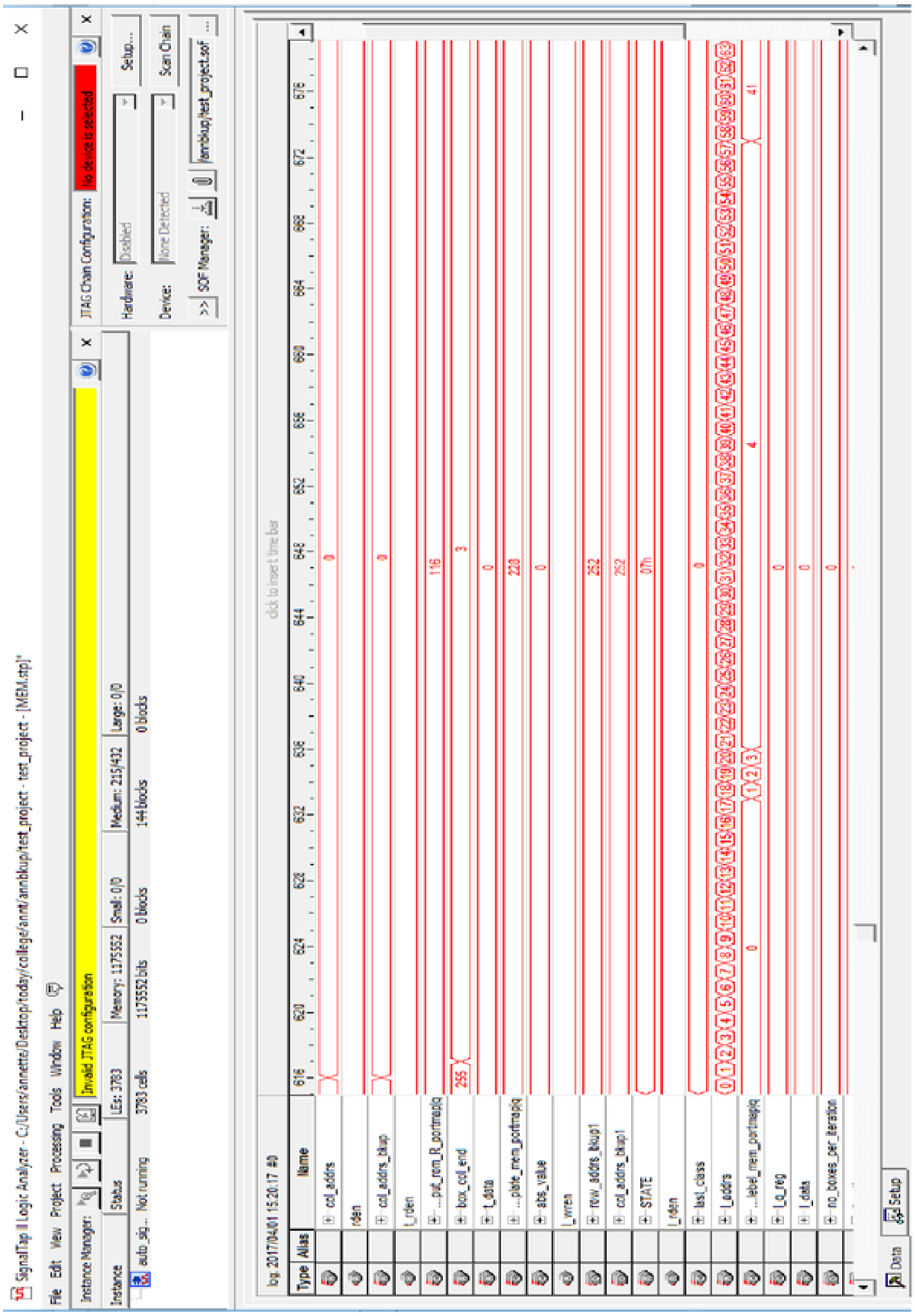


Figure 5.12 Debugger result of segmentation.

Figure 5.13 depicts the label count corresponding to the segmented labels ranging from 2 to 33. The count of label 3 is found to be highest and it represents the background blue in the segmentation output.

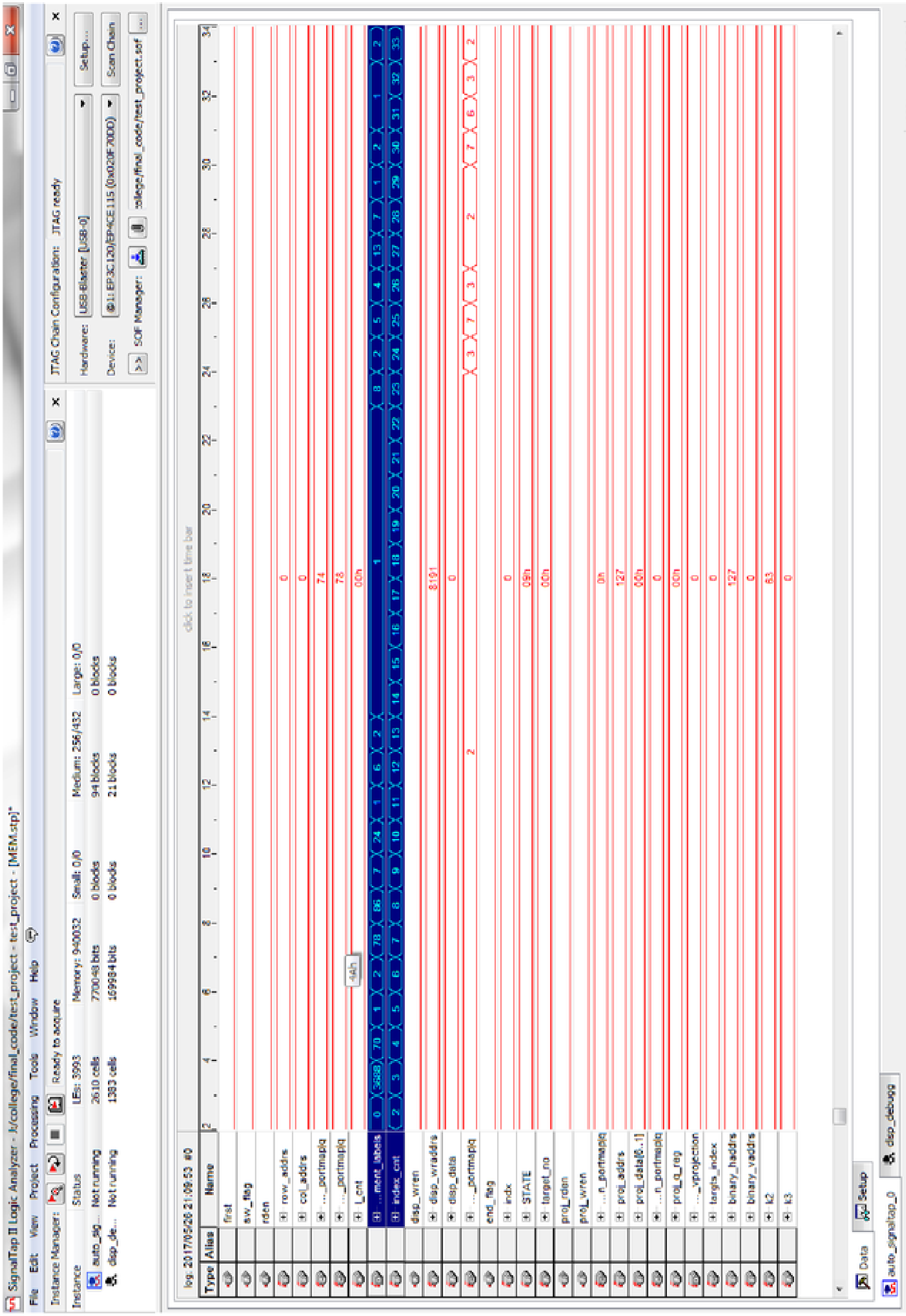


Figure 5.13 Label count corresponding to labels 2 to 33.

Figure 5.14 shows the label count corresponding to the segmented labels ranging from 28 to 59.

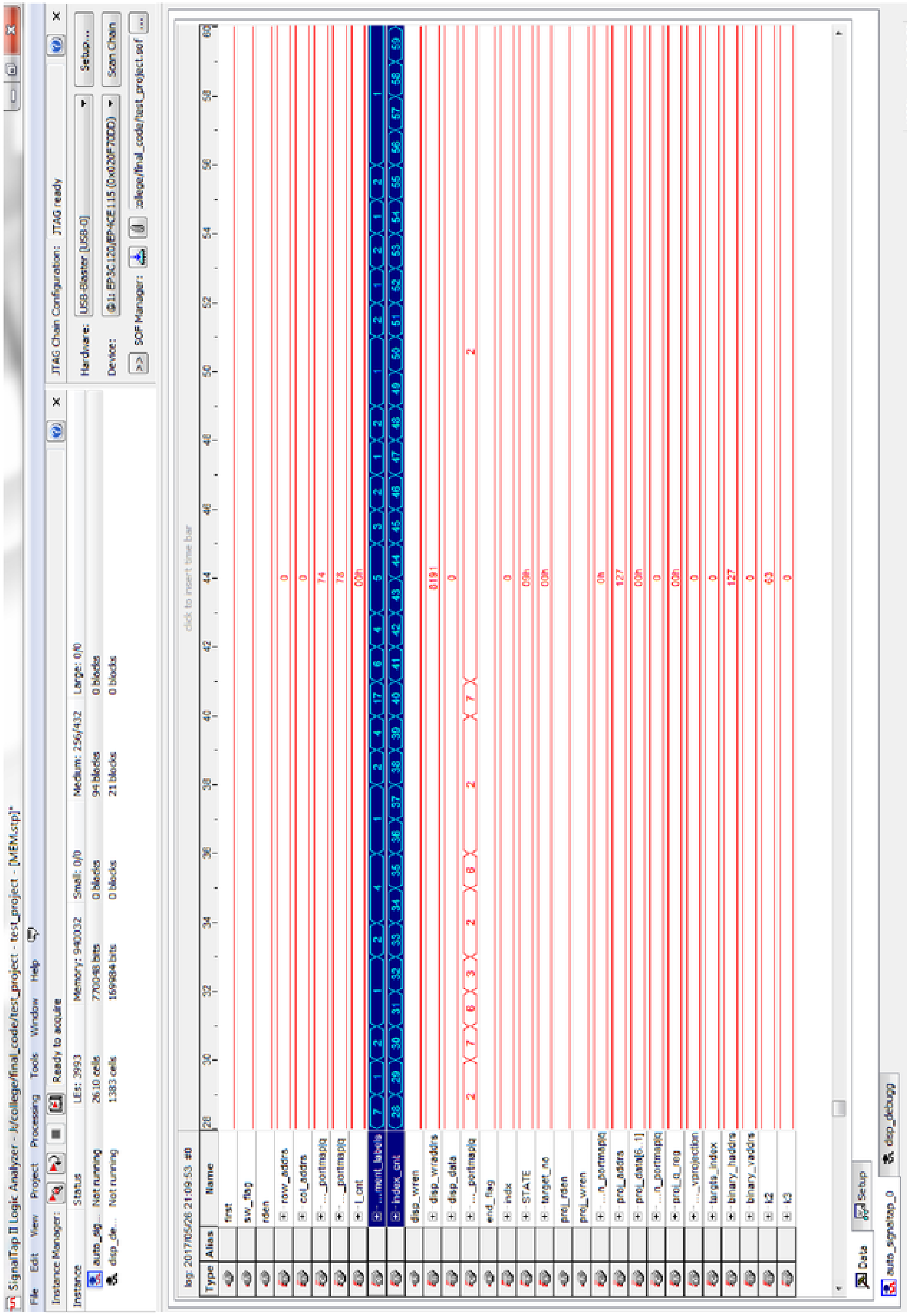


Figure 5.14 Label count corresponding to labels 28 to 59.

Figure 5.15 depicts the label count corresponding to the segmented labels ranging from 51 to 82.

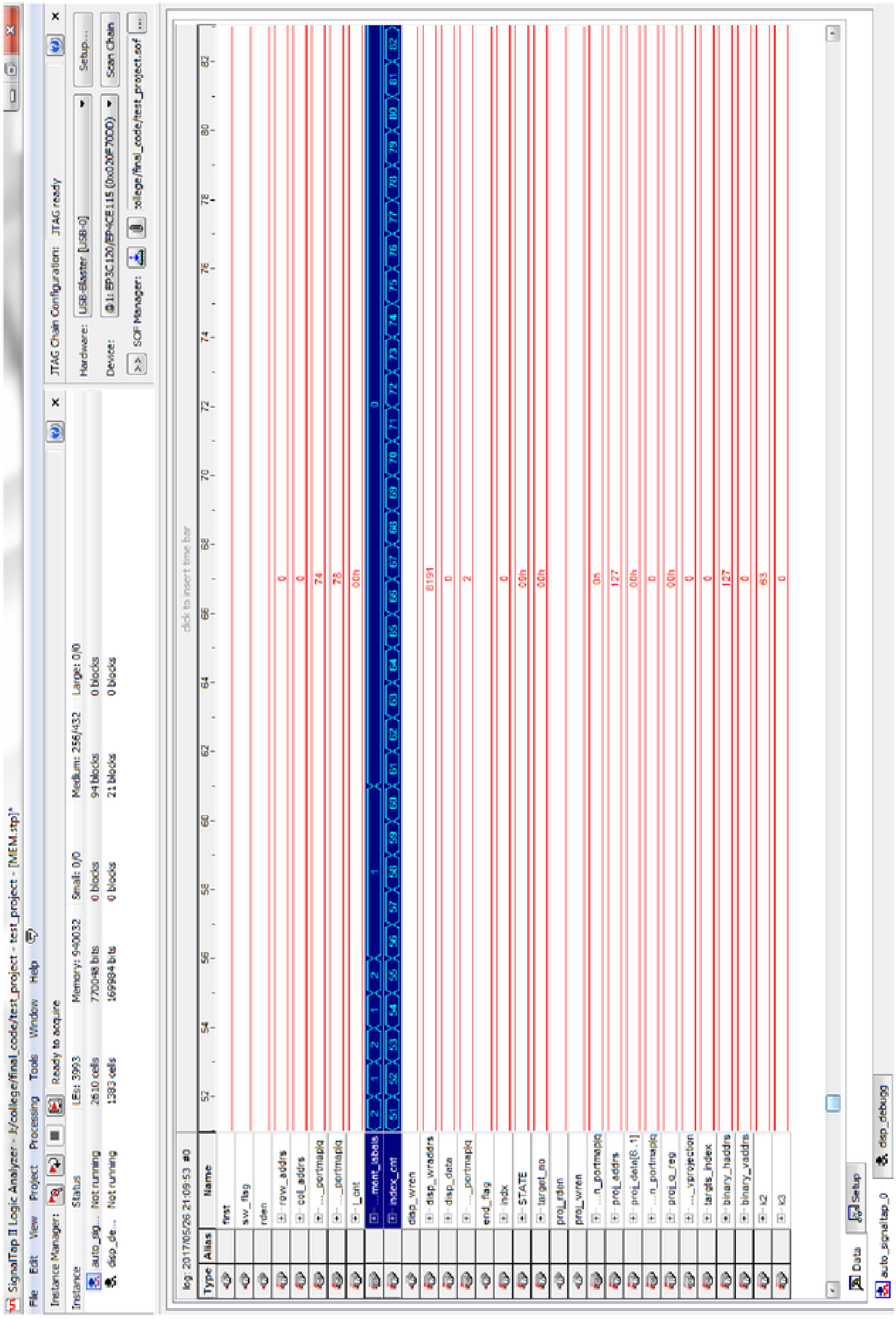


Figure 5.15 Label count corresponding to labels 51 to 82.

CHAPTER 6

CONCLUSION

The major contribution of this thesis is the histogram based image segmentation method to extract the targets in the satellite image. It is a unique approach to describe the region of an image that comprises of interested information. The algorithm introduced is automatic one and hence demands very little interactions. The important and key parameter of the proposed work rely indefinitely on automatic thresholding algorithm. It is found that Kittler and Illingworth's thresholding algorithm provides a good automatic threshold value on the histogram considered and performs well on our image of interest. Since extraction is solely based on intensity, pixel intensities corresponding to regions which are identical to targets are also extracted. The ROI image thus obtained is analyzed with the template matched image to classify the targets. Template matching based on masks reduces the computation time. The efficiency of obtaining true targets from this proposed algorithm is seen to be highly effective. For real time applications, design is invoked on hardware. The results are obtained for image size of 256x256, but the approach discussed can be used for images of any size. ROI extraction based on segmentation is successfully implemented on customised board which uses Altera cyclone III FPGA. The future work is to implement the validation of targets using correlation method on the hardware.

REFERENCES

[1] Tong Li, Jumping Zhang, Xiaochen Lu and Ye Zhang, SDBD: A hierarchial ROI detection approach in large scale remote sensing image, IEEE

Geoscience and Remote Sensing Letters, Vol.14, Issue: 5, 2017, pp: 699-703.

[2] K Suresh Manic, R krishnapriya and V Rajnikanth, Image multithresholding based on Kapur's/Tsallis entropy and firefly algorithm, Indian journal of science and technology, Vol.9(12), ISSN:0974-5645, 2016.

[3] SenthilKumaran.N and Vaithegi.S, Image segmentation by using thresholding technique for medical images, International Journal in Computer Science and Communication Engineering, Vol.1, 2016.

[4] Zhongwen Hu, Qingquan Li, Qian Zhang and Guoseng Wu, Representation of block-based image feature in a multiscale framework for built up area detection, Journal on remote sensing and application, ISSN: 2072-4292, 2016.

[5] Warinthorn Kiadtikornthaweeyot and Adrian R.L. Tatnall, Region of Interest detection based on histogram segmentation for satellite image, The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol.XLI-B7, 2016, pp: 249-255.

[6] Amit Raikar P.G and Geeta Hanji, Automatic building detection from satellite images using internal gray variance and digital surface model, International Journal of Computer Applications, Vol.145, Issue:3, ISSN: 0975 – 8887, 2016.

[7] Paridhi Swaroop, Banasthali Vidhyapeeth and Neelam Sharma, An overview of various template matching methodologies in image processing, International Journal of Computer Applications, Vol.153, Issue: 10, ISSN: 0975 – 8887, 2016 .

[8] Aditya Rachman Patra, Fadhil Mochammad and Hans Heridan, FPGA implementation of template matching using binary sum of absolute difference, IEEE International Conference on System Engineering and Technology (ICSET), ISSN: 2470-640X, 2016.

[9] Animesh Chandra Roy, Muhammad Kamal Hossen and Debashis Nag, License plate detection and character recognition system for commercial vehicles based on morphological approach and template matching, IEEE International Conference on Electrical Engineering and Information Communication Technology (ICEEICT), ISBN: 978-1-5090-2906-8, 2016.

[10] Yuri Marchetti Tavares, Nadia Nedjah and Luize de Macedo Mourelle, Hardware/software co-design system for template matching using particle swarm optimisation and pearson's correlation coefficient, IEEE Latin

American Conference On Computational Intelligence (LA-CCI), ISBN: 978-1-5090-5105-2, 2016.

[11] Adriana Romero, Carlo Gatta and Gustau Camps, Unsupervised deep feature extraction for remote sensing image classification, IEEE Transactions on Geosciences and Remote Sensing, Vol.54, Issue: 3, ISSN: 1558-0644, 2015, pp: 1349-1362.

[12] Girish Kumar Tanwar and Shiv Kumar, Analysis of template matching method using correlation score, International Journal of Engineering and Technical Research, Vol.3, Issue: 12, ISSN: 2321-0869, 2015.

[13] Aarti Sharma, Automatic vehicle detection using various object detecting algorithm and thresholding methods, International Journal on Future Revolution in Computer Science and Communication Engineering, Vol.1, Issue: 1, 2015, pp:16 – 28.

[14] Hassan Id Ben Idder and Nabil Laachfoubi, Unsupervised multi-level thresholding method for weather satellite cloud segmentation, International Journal of Computer Applications, Vol.118, ISSN: 0975-8887, 2015.

[15] K. Sankar and Dr. M. Prabakaran, An efficient template matching algorithm for lung cancer detection using multi-resolution histogram based image segmentation, International Journal of Enhanced Research in Science Technology and Engineering, Vol.3, Issue: 1, ISSN: 2319-7463, 2014, pp:71-75.

[16] A. Atchaya, V. Rajinikanth and J.P. Aashiha, Gray-level histogram based multilevel threshold selection with bat algorithm, International Journal of Computer Applications, Vol.93, Issue: 16, ISSN: 0975 – 8887, 2014.

[17] Lizy Abraham and M. Sasikumar, Vehicle detection and classification from high resolution satellite images, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol.II-1, 2014.

[18] Y. Raghavender Rao, Nikhil Prathapani and E. Nagabhooshanam, Application of normalized cross correlation to image registration, International Journal of Research in Engineering and Technology, Vol.3, Issue: 5, ISSN: 2321-7308, 2014.

[19] K. Bhargavi and S. Jyothi, A survey on threshold based segmentation technique in image processing, International Journal of Innovative Research and Development, Vol. 3, Issue: 12, ISSN 2278 – 0211, 2014, pp: 234-238.

[20] Gururaj Banakar and Ravikumar.A.V, Real time object visual inspection based on template matching using FPGA, International Journal of Scientific and Engineering Research, Vol.4, Issue: 8, ISSN: 2229-5518, 2013.

[21] Shilpa Kamdi and R.K.Krishna, Image segmentation and region growing algorithm, International Journal of Computer Technology and Electronics Engineering (IJCTEE), Vol. 2, Issue: 1, ISSN: 2249-6343, 2013.

[22] Noor A. Ibraheem and Rafiqul Z. Khan, Multiple Histogram technique for robust skin color based segmentation, American Journal of Engineering Research, Vol.2, Issue: 5, ISSN: 2320-0847, 2013, pp: 50-54.

[23] P. Daniel Ratna Raju and G. Neelima, Image segmentation by using histogram thresholding, IJCSET, Vol. 2, Issue: 1, ISSN: 2231-0711, 2012, pp: 776-779.

[24] R. C. Gonzalez and R. E. Woods, Digital Image Processing, 3 Edition, 2008.

[25] N. Nacereddine, L. Hamami, M. Tridi and N. Oucief, Non-Parametric histogram-based thresholding methods for weld defect detection in radiography, World Academy of Science, Engineering and Technology, 2007.

[26] http://www.satimagingcorp.com/gallery/

[27] http://www.altera.com/products/software/sysgen/app_docs/user_guide.htm

ANNEXURE A

Technical Paper

Annette Nayana Palanna and Dr. Veena Devi Shastrimath V., “**Target Detection in Satellite Images**”, is presented and published in 7th International Conference on Emerging Trends in Engineering (ICETE 2017) held on 12th May 2017 at N.M.A.M. Institute of Technology, Nitte, India.

ANNEXURE B

This section includes the datasheet details regarding the Altera cyclone III FPGA.

Target detection in Satellite Images

ORIGINALITY REPORT

%13	%10	%8	%8
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.iaset.us Internet Source	%1
2	Warinthorn Kiadtikornthaweeyot, Adrian R. L. Tatnall. "REGION OF INTEREST DETECTION BASED ON HISTOGRAM SEGMENTATION FOR SATELLITE IMAGE", ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 2016 Publication	%1
3	www.altera.com Internet Source	%1
4	www.srmuniv.ac.in Internet Source	%1
5	Submitted to CVC Nigeria Consortium Student Paper	%1
6	Submitted to Universiti Sains Malaysia Student Paper	%1
7	Submitted to Universiti Kebangsaan Malaysia Student Paper	%1

8	Haralick, R.. "Linear manifold clustering in high dimensional spaces by stochastic search", Pattern Recognition, 200710 Publication	%1
9	Alexander Drobchenko. "Thresholding-based detection of fine and sparse details", Frontiers of Electrical and Electronic Engineering in China, 06/2011 Publication	%1
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14	instruct1.cit.cornell.edu Internet Source	<%1
15	etd.ohiolink.edu Internet Source	<%1
16	Lecture Notes in Computer Science, 2013. Publication	<%1
17	Siddiqui, A.M.. "A locally constrained radial basis function for registration and warping of images", Pattern Recognition Letters,	<%1

20090301
Publication

18	www.it.lut.fi Internet Source	<%1
19	www.erpublication.org Internet Source	<%1
20	psm.fke.utm.my Internet Source	<%1
21	quartushelp.altera.com Internet Source	<%1
22	Idder, Hassan Id Ben, and Nabil Laachfoubi. "Cloud Motion Estimation in Satellite Image Sequences by Tracking Skeleton Critical Points Using Lucas-Kanade Method", 2016 13th International Conference on Computer Graphics Imaging and Visualization (CGiV), 2016. Publication	<%1
23	Communications in Computer and Information Science, 2011. Publication	<%1

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