Vision Based Chassis Inspection

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Submitted to the College of Engineering

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Title

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According to the project supervisor and examiner committee members,
this project is submitted to the Department of Mechanical Engineering at the College of Engineering and technology in partial fulfillment of the requirements for the Bachelor in Automotive Engineering

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Department Head signature

…….

Dedication

To our Families … For their support

To our Teachers … For help us until the end

To our Friends … Who give us positive sentiment

To oppressed people throughout the world and their struggle for social justice and egalitarianism

To our great Palestine

To my supervisor Dr. Diya Arafah

To all who made this work is possible

Acknowledgment

We would like to express our gratitude for everyone who helps us during the graduation project , starting with endless thanks for our supervisor Dr. Diya Arafah who didn't keep any effort in encouraging our to do a great job , providing us with valuable information and advices to be better each time .Thanks for the continuous support and kind communication which great effect regarding to feel interesting about what we are working on .

Finally, Thanks are extended to the "Automotive and Mechanical society " for the beneficial lectures provided .

Abstract

People in life face a lot of problems, while the vehicle chassis inspection is one of the most important things to be solved which it's the backbone of the car and it's the basic frame work of the automobile. The conventional method of inspecting the chassis of a vehicle is worthwhile but not accurate to locate the damage point and time consuming.

The main idea of this project is to make the chassis test easier than the conventional method. Since the technical faces a lot of difficulties in checking the chassis and inaccurate information, a new approach to test the chassis was studied in this project by taking an image of the vehicle's chassis by using a camera and then insert it in the software program "LabVIEW". By this way it would be an automated checking test witch it detect the cracks in the chassis easier and more accurate.

نظرا إلى المشاكل التي يواجهها العديد من البشر, تعد مشكلة فحص هيكل السيارة السفلي من أهم المشاكل التي يجب حلها , حيث يعد الهيكل السفلي الجزء الأساسي والعمود الفقري للمركبة. حيث أن الطريقة التقليدية في فحص الهيكل السفلي تعد مجدية ولكنها تواجه العديد من المشاكل خاصة في دقة تحديد موقع الضرر.

الفكرة الرئيسية للمشروع هي جعل فحص الهيكل السفلي أكثر سهولة مقارنة بالطريقة التقليدية. حيث أن التقني يواجه الكثير من الصعوبات في فحص الهيكل السفلي ودقة النتائج, في هذا المشروع تم دراسة تقنية جديدة في فحص الهيكل السفلي من خلال اخذ صوره باستخدام الكاميرا للهيكل السفلي الخاصة بالمركبة المتضررة وإدخالها إلى برنامج برمجي "LabVIEW" . ومن خلال هذا الفحص يتم الكشف وتحديد موقع الكسر في الهيكل السفلي بأكثر سهوله ودقه.

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Chapter 1

1.1 Overview

Break down of cars leads to a large distention in our daily life, where our life and jobs may be affected or cutoff due to car disrupt, this leads due to a lot of problems. There is incident will affect on chassis that will make a dangerous issue it has to be checked quickly because it may incur the car, driver and passenger to the danger, the test of chassis it may done by using conventional method or other modern methods like using "Car O Liner" system. So, in spite of progress in the technology there is still a malfunction in vehicles but we can find them quickly using technology so in other side we can test and check the chassis using automated method and technology. So, the Chassis is the under part of the vehicle consisting of the frame on which the body is mounted and it considered as the backbone of the vehicle due to it hold all vehicle part whether wheels, gearbox and engine. Every frame has a special identification number (VIN) to guarantee the owner rights.

A vehicle frame is the main supporting structure of a motor vehicle to which all other components are attached, like the backbone of the human body.

Until the 1930s, virtually every car had a structural frame, separate from its body. This construction design is known as body-on-frame. Over time, nearly all passenger cars have migrated to anybody construction, meaning their chassis and bodywork have been integrated into one another.

Automobile increased complexity leads to the new weight reduction demand, made this type of structure unviable. Form 1960s most of the small passenger cars switched to unibody construction, leaving trucks and large cars using conventional frames.

The chassis structure contains the power train and mechanical components, while the body is a separate structure. There are no mechanical links between the body and chassis, uses square section tubes for easier connection to the body panels, or circular section provides the maximum strength.

1.2 Literature Review

1. TruckCam

The digital TruckCam Camera Wheel Alignment System is one of the most advanced systems on the world market. With the integrated gyro and electronic inclinometers, precise and accurate measurements are guaranteed.

The system is designed for measuring all wheel angles, including parallelism between axles, on commercial (heavy duty) vehicles, such as trucks, trailers, buses, vans, mobile cranes and agricultural vehicles. The TruckCam camera Wheel Alignment System enables dynamic toe and camber measurements while in driving position, by using the unique TruckCam rolling method.

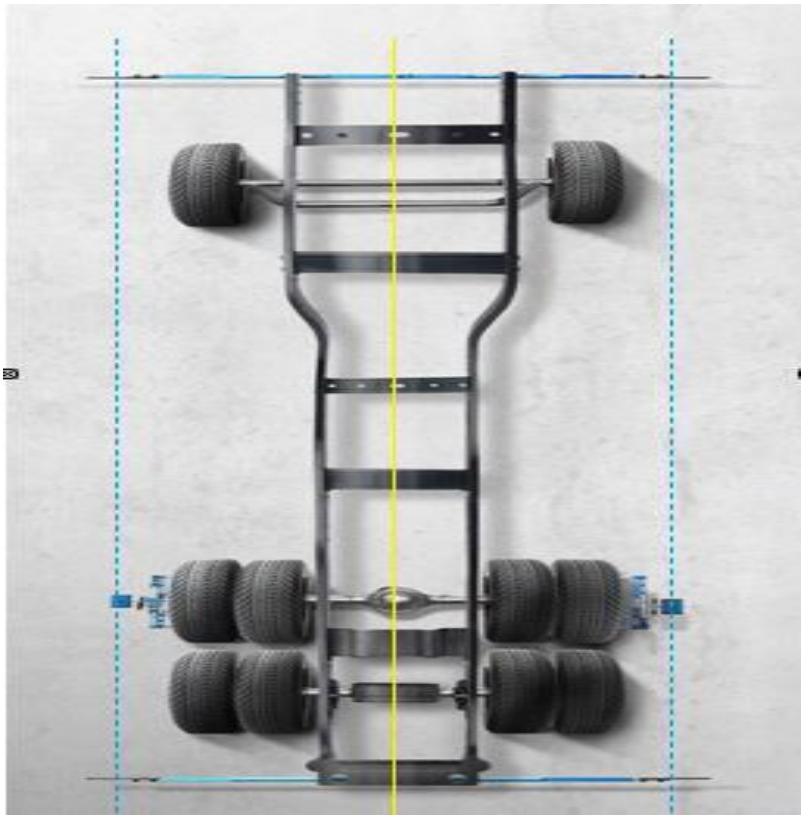


Figure 1.1 Truck-Cam Wheel Alignment

TheTruckCam camera Wheel Alignment System uses the centerline principle to determine the position of axles and individual wheels in relation to the vehicle centerline.

The centerline of the vehicle is determined by the self centering frame gauges hanged in the front and rear of the chassis or body. The reflective targets are placed on an equal distance from this centerline, creating an imaginary line on each side of the vehicle parallel to the vehicle centerline.

The camera measures distance and position in relation to the front and rear targets. The system is able to calculate all wheel angles for that particular wheel and axle in relation to the centerline .

2. Car-O-Liner

Car-O-Liner is dedicated to creating substantial value through leading edge concepts, technology and information that enable customers to improve their operations. Car-O-Liner is the leading global provider of high-quality, advanced technologically collision repair equipment to the automotive aftermarket.

The Car-O-Liner system include : computerized and mechanical measuring systems , comprehensive vehicle measurement data, alignment benches and frame pulling equipment and Vehicle anchoring systems Spot and MIG/MAG welding systems.

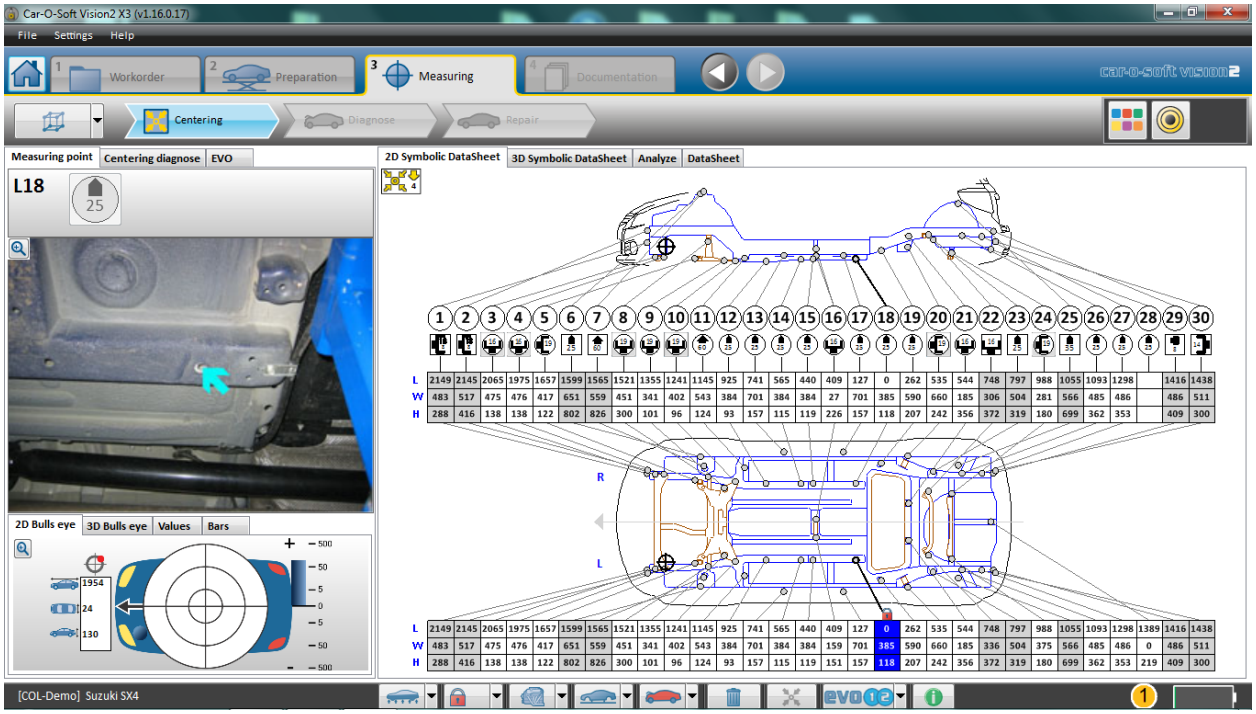


Figure 1.2 Determining the distance between the points

This program based on determining the distance between the points that selected by the company to check if there is a difference with the specific value and the difference in the safe range. This process done by a special tool for Car-O-Liner , the comparison is between the current car and the reference module form the mother company and the process differ from car to another .

1.3 Importance of the project

The project aims to making easy the method of testing chassis frame while it's very important and its one of the most important problems in vehicle, this project make the chassis test easier than the conventional method since the tester faces a lot of difficulties in checking the chassis with Inaccurate data. So by using a software program we can detect the lactation of cracks in vehicle chassis.

1.4 Project objectives

The main objective of the project is to combine between the technology and the chassis testing using LabVIEW program due to its simplicity, which has the ability to help in detect the location of cracks in chassis and view it as an image output.

1.5 Methodology

The conventional method to find the damaged part in the chassis should be assisted carefully to be measured. The project solves this issue by using vision system to get an accurate information of the structure.

At the first, the processes will be start by taking an image of a part the chassis of the existing vehicle. While the chassis will be divided into several part and analyze every part individual. Then insert the image to the computer by memory card to use it in software program (LabVIEW) and make a many image processing at the image to detect the location of crack regions in the chassis. Then LabVIEW will view the processed image of the chassis at front panel with red frame around the crack regions if found.

1.6 Time Plan

Table 1. 1 Schedule Time – First Semester

Task\Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Identifying the project idea																
Literal review																
Chassis study																
Identify and study LabVIEW program																
Writing and documentation																

Table 1. 2 Schedule Time – Second Semester

Task\Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Project Equipments																
LabVIEW Coding																
Project Testing																
Writing and documentation																

1.7 Budget

Table 1. 3 Total cost

Tools & Device	No.	Piece Price(NIS)	Price (NIS)
Camera	1	2000	2000
Lens	1	1500	1500
Camera base	1	150	150
Computer	1	2700	2700
Searchlight	2	200	400
Total			6750

CHAPTER 2

CHASSIS

2.1 Introduction

2.2 Chassis layouts and its main components

2.3 Chassis frame functions

2.4 Chassis frame Cross-sections

2.5 Chassis frame loads

2.6 Defects in frame

2.7 Conventional Chassis frame inspection

Chapter 2

2.1 Introduction

The main reason of the project is to reduce the time for checking the vehicle frame and to improve the accuracy of the test, the technical may face a difficultly in detection of the diagnosis of vehicle chassis frame accurately due to some reasons or obstacles that may hide the damages of the frame and making less accuracy in testing and results. So, it's too important to solving these problems to guarantee the buyer rights and the safety of driver and passengers on roads.

So, in this project will find the damage in the chassis in automated way alternative to the conventional method, this will be by using computers and software. The method of working is to take an image of the current chassis and insert it to the LabVIEW software to locate the region of the crack if found.

Chassis frame is the basic frame work of the automobile. It supports all parts related to automobiles are attached to it only. All the systems related to automobile like power plant, transmission, steering, suspension, braking system.

The separate frame body type of vehicle construction (fig 2.2) is the most common frame used when produce acargo vehicles. In this type of construction, the frame and the vehicle body are made separately. The frame is designed to support the weight of the body and absorb all of the loads imposed by the terrain, suspension system, engine, drive train, and steering system, and the body merely contains and, in some cases, protects the cargo. The body generally is bolted to the frame at a few points to allow for flexure of the frame and to distribute the loads to the intended load-carrying members.

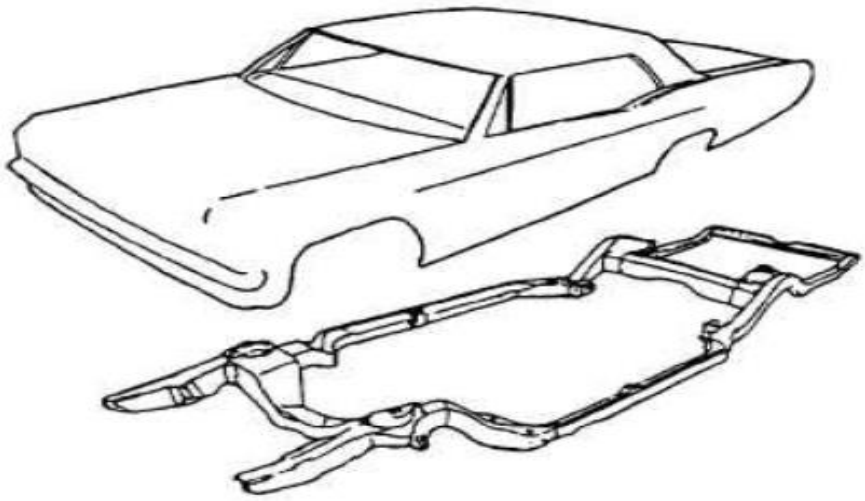


Figure 2. 1 Separate frame and body

2.2 Chassis layouts and its main components

"Chassis" a French term which means the complete automobiles without body and it includes all the systems like power plant, transmission, steering, suspension, wheels tires, auto electric system etc. If Body is also attached to it then it is known as the particular vehicle as per the shape and design of the body. [2]

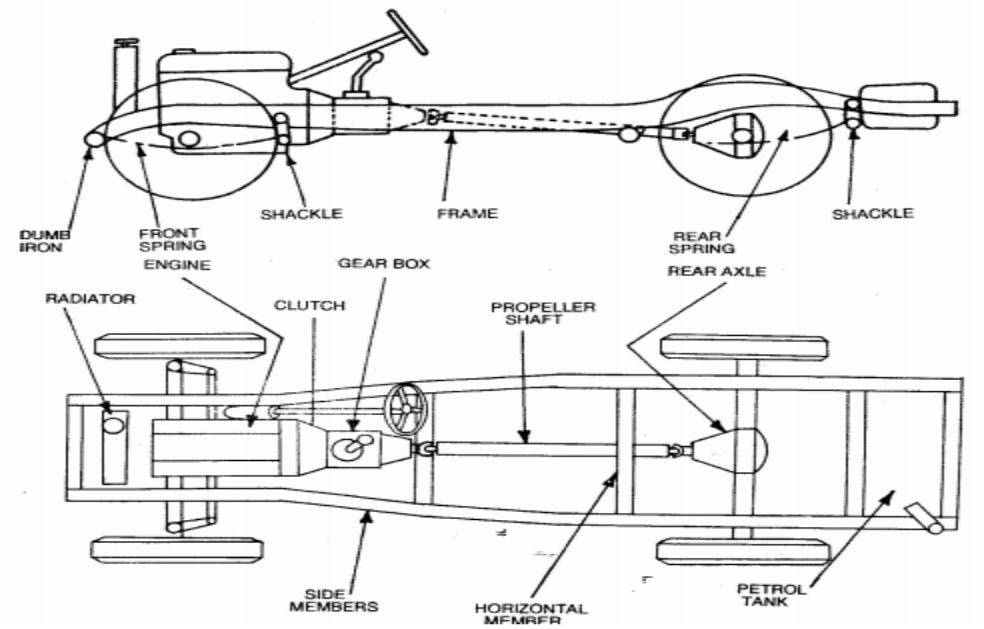


Figure 2. 2 Layout of chassis

2.3 Chassis frame functions

The main function of the chassis is to carryall the stationary loads attached to it and loads of passenger cargo carried in it, and to withstand tensional vibration caused by the movement of the vehicle. Also, it is used to withstand the centrifugal force caused by cornering of the vehicle and to control the vibration caused by the running of the vehicle also to withstand bending stresses due to rise and fall of the front and rear axles.

2.4 Chassis frame cross-sections

The conventional frame is also known as Non-load carrying frame. In this types of frame, the loads on the vehicle are transferred to the suspension by the frame which is the main skeleton of the vehicle. The channel section is used in long members and box section in short members. Tubular section is used now-a-days is three wheelers, scooters, matadors and pickup vans. The frames should be strong enough to bear load while sudden brakes and accidents.

There are different types of chassis frame sections:

1. Channel section (fig 2.3)
2. Box section (fig 2.4)
3. Tubular section (fig 2.5)

Figure 2. 3 Channel section

Figure 2. 4 Box section

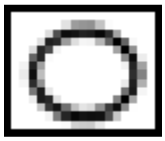


Figure 2. 5 Tubular section

2.5 Chassis frame loads

Stationary loads, namely the loads of permanent attachment like all the parts of the chassis and body. A short duration loads while turning, braking and a Momentary load while quick acceleration, sudden braking. Loads applied while crossing roads of irregular and uneven surfaces and loads caused by sudden accidents, head on collusions, finally loads caused by irregular and overloading of vehicle.

- Vertical Bending:

When the weight or the force located at the middle of the wheelbase.

- Longitudinal Torsion:

When the front and rear diagonally opposite and road wheels roll over bumps simultaneously, two ends of the chassis will have twisted in opposite directions.

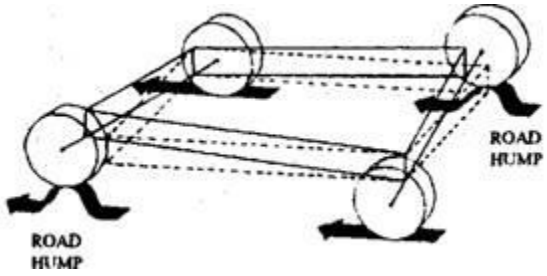


Figure 2. 6 Longitudinal Torsion

- Lateral Bending:

The chassis may be exposed to a lateral "side" forces due to possibly to the camber of the road, side wind, centrifugal force as when turning a corner. The adhesion reaction of the road wheel tires will oppose these lateral forces.

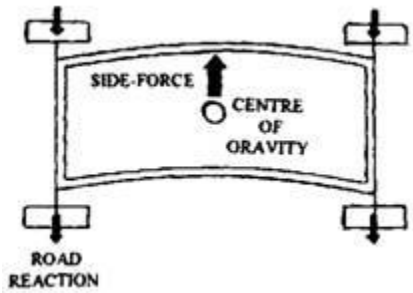


Figure 2. 7 Lateral Bending

2.6 Defects in frames

The only defect occurs after an accident is the alignment front, the causes are:

- The dumb irons or side members may be bent.
- Cross members may be buckled.
- Some rivets may be loose or broken.
- Cracks
- Dislocated parts
- Broken welds
- Buckling

Defects in frames and body generally occur due to severe impacts on rough roads and collision with other objects or vehicles. Depending upon the nature of collision, the defects of the following kinds may occur.

- Misalignment in horizontal and/or vertical plane.
- Twisting of main frame and/or sub-frames
- Twisting of main frame and/or sub-frames
- Bent side members and/or dumb iron.
- Broken or loose gusset plates and rivets.

2.7 Conventional Chassis frame inspection

A conventional method of testing vehicle chassis is by manually checking and simple equipment that a tester use, by this way a tester will locate the damaged region of frame.

Determine if the damage is confined to the body or of it involves functional parts (suspension, wheels and engine). Also, systemically inspect damage of the components along the path of the impact, and find the point where there is no longer any evidence of damage.

Finally, check body dimensions and known the correct body measurements of un undamaged vehicle. Whenever to check the vehicle is subjected to a measure collision on a level surface then take four points at each side of the frame, then measure the diagonals between corresponding points.

A visual check generally reveals major misalignment, but in case this fails to indicate the defect, the frame checking is as follow:

- Wheel Base Check:

The front wheels are set in the straight-ahead position and the wheelbase on each side is checked.

- Alignment Check:

To verify parallelism of the rear wheels with each other, a cord or straight edge is held against the rear wheel. Then the front wheel is turned until it is parallel with the cord. The clearance (if any) between the wheel and cord should be the same on both sides

- Plumb-Line Check:

To verify parallelism of the rear wheels with each other, a cord or straight edge is held against the rear wheel. Then the front wheel is turned until it is parallel with the cord. The clearance (if any) between the wheel and cord should be the same on both sides.

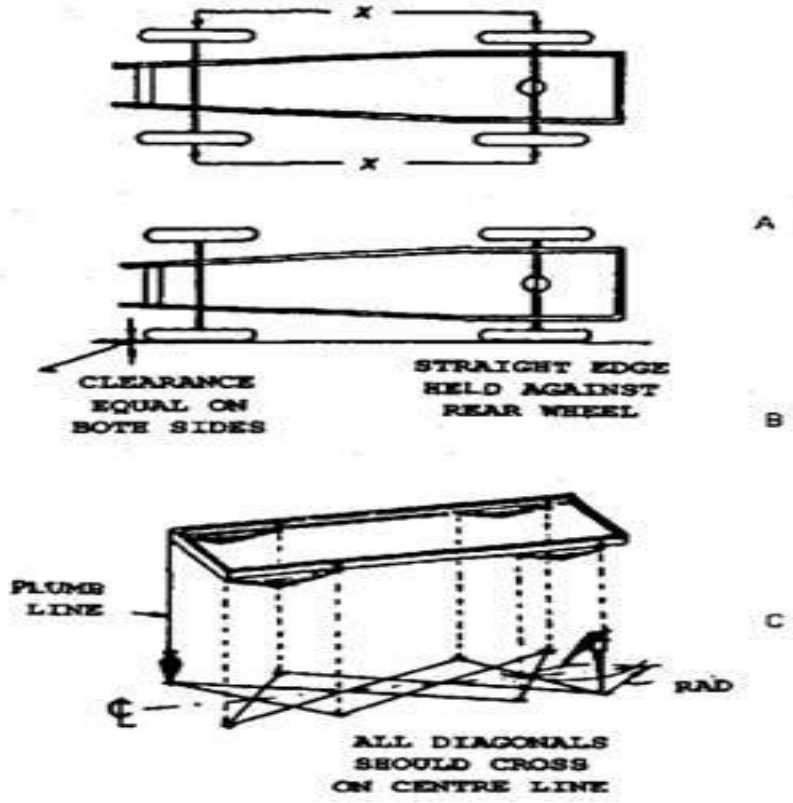


Figure 2. 8 Plumb-Line Check

CHAPTER 3

Digital Image Processing

3.1 Introduction

3.2 pre-processing

3.3 Grayscale Method

3.4 Edge Detection

3.5 Threshold

Chapter 3

Digital Image Processing

3.1 Introduction

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms core research area within engineering and computer science disciplines too. For the last decades, the world has been witnessing an extreme use of technology in every aspect of life. Today's trend is to computerize and automate anything and every possible thing to augment accuracy and precision, to save money and time, and just to move it to the next level. One significant feature of this trend is the dramatic usage of various image-processing techniques to achieve many goals. Today, image processing is utilized in manufacturing, medical field, education and other fields. Thus, we are planning to use assorted image-processing techniques to examine distinct chassis parts to their references so as to conclude the health status of those parts.

Image processing basically includes the following three steps:

- Importing the image via image acquisition tools
- Analyzing and manipulating the image;
- Output in which result can be altered image or report that is based on image analysis.

There are two types of methods used for image processing namely, analogue and digital image processing. Analogue image processing can be used for the hard copies like printouts and photographs. Image analysis use various fundamentals of interpretation while using these visual techniques. Digital image processing techniques help in manipulation of the digital images by using computers. The three general phases that all types of data have to undergo while using digital technique are pre-processing, enhancement, and display, information extraction.

Nowadays image processing is becoming an important assisting tool in many branches of science such as computer science, electrical and engineering, robotics, physics, chemistry, environmental science ,and biology, Due to this it is importance to develop new ideas in that field or introduce a new application in digital image correlation Serves in vehicle inspection.[3]

3.2 pre-processing

The first stage in every image-processing application starts with pre-processing stage. In the pre-processing phase, the images will be prepared by handling the noise and the resolution for further processing. In general, the images suffer from intensity inconsistency within the same image, which means that some parts of the image will be exposed to light more than other parts. Moreover, in order to compare different images, the images need to have unified scaling to make the best of the comparison. Thus, the pre-processing stage is very critical to overwhelm these flaws in the images.

- **Noise Handling**

The noise will always be a crucial factor that influences the usage of images in various application. Its presence in images is due to surrounding conditions at the acquisition time. There are several types of noise that can exist in the image. One example for such a noise is the impulse noise, which co-called salt-and-pepper noise. This kind of noise is introduced to the image usually by the poor condition of the camera or the lack of appropriate circumstances in shooting. Such

- **Image Enhancement:**

Image enhancement techniques have been widely used in many applications of image processing where the subjective quality of images is important for human interpretation. Contrast is an important factor in any subjective evaluation of image quality. Contrast is created by the difference in luminance reflected from two adjacent surfaces. In other words, contrast is the difference in visual properties that makes an object distinguishable from other objects and the background. In visual perception, contrast is determined by the difference in the color and brightness of the object with other objects. Our visual system is more sensitive to contrast than absolute luminance; therefore, we can perceive the world similarly regardless of the considerable changes in illumination conditions. Many algorithms for accomplishing contrast enhancement have been developed and applied to problems in image processing.

If the contrast of an image is highly concentrated on a specific range, e.g. an image is very dark; the information may be lost in those areas which are excessively and uniformly concentrated. The problem is to optimize the contrast of an image in order to represent all the information in the input image.

3.3 Grayscale Method

Grayscale images are the simplest to consider, conversion of a color image into a grayscale image inclusive of salient features is a complicated process. The converted grayscale image may lose contrasts, sharpness, shadow, and structure of the color image. To preserve contrasts, sharpness, shadow, and structure of the color image a new algorithm has proposed. To convert the color image into grayscale image the new algorithm performs RGB approximation, reduction, and addition of chrominance and luminance. The grayscale images generated using the algorithm in the experiment confirms that the algorithm has preserved the salient features of the color image such as contrasts, sharpness, shadow, and image structure. When converting an RGB image to grayscale, we have to take the RGB values for each pixel and make as output a single value reflecting the brightness of that pixel.

Figure 3.1 RGB Image

Figure 3.2 Grayscale Image

3.4 Edge Detection

In this approach, the object's boundaries are used to detect the object in an image. These boundaries or edges are represented in digital images as points at which image intensity significantly changes. This change can be abrupt in step edges or can occur over a finite distance in ramp edges. Edge detection is accomplished by deciding the relationship among adjacent pixels. Then intensities' discontinuities are delimited and preserved as the edges of objects. Edge

based detection can be classified into two basic categories, gradient-based algorithms and adaptive edge-detection algorithms.

- The following list includes the main parameters of this model:

- Edge strength, defines the minimum difference in the grayscale values between the background and the edge. The edge strength is also called the edge contrast. The strength of an edge can vary for the following reasons:

    - Lighting conditions—If the overall light in the scene is low, the edges in image will have low strengths.
    - Objects with different grayscale characteristics—The presence of a very bright object causes other objects in the image with lower overall intensities to have edges with smaller strengths.

- Edge length, defines the distance in which the desired grayscale difference between the edge and the background must occur. The length characterizes the slope of the edge. Use a longer edge length, defined by the size of the kernel used to detect edges, to detect edges with a gradual transition between the background and the edge.

- Edge location, The *x*, *y* location of an edge in the image.

- Edge polarity, defines whether an edge is rising or falling. A rising edge is characterized by an increase in grayscale values as you cross the edge. A falling edge is characterized by a decrease in grayscale values as you cross the edge. The polarity of an edge is linked to the search direction.

3.5 Threshold

Thresholding consists of segmenting an image into two regions: a particle region and a background region. In its most simple form, this process works by setting to white all pixels that belong to a gray-level interval, called the threshold interval, and setting all other pixels in the image to black. The resulting image is referred to as a binary image. For color images, three thresholds must be specified, one for each color component. And is a process of converting a grayscale input image to a bi-level image by using an optimal threshold.

The purpose of thresholding is to extract those pixels from some image which represent an object (either text or other line image data such as graphs, maps). Though the information is binary the pixels represent a range of intensities. Thus the objective of binarization is to mark pixels that belong to

true foreground regions with a single intensity and background regions with different intensities.

The threshold can be chosen manually or by using automated techniques. Manual threshold selection is normally done by trial and error, using a histogram as a guide. Automated thresholding techniques select a threshold which optimizes a specified characteristic of the resulting images. These techniques include clustering, entropy, metric, moments, and interclass variance.

For a thresholding algorithm to be really effective, it should preserve logical and semantic content. There are two types of thresholding algorithms:

- Global thresholding algorithms
- Local or adaptive thresholding algorithms

In global thresholding, a single threshold for all the image pixels is used. When the pixel values of the components and that of background are fairly consistent in their respective values over the entire image, global thresholding could be used. In adaptive thresholding, different threshold values for different local areas are used.

Hysteresis basically consists of determining a high threshold that allows a group of pixels to be classified as edge points without using connectivity information among them. A low threshold then determines which group of pixels will not be edge points and permits only those points that increment the connectivity of the previously determined edge points to be aggregated as edge points.

CHAPTER 4

LabVIEW

4.1 LabVIEW (Virtual Instrument Engineering Workbench)

4.2 Operation

4.3 Benefits

4.4 NI Vision Development Module

Chapter 4

4.1 LabVIEW(Virtual Instrument Engineering Workbench)

LabVIEW is an application program development software and a system-design platform and development environment for a visual programming language .

LabVIEW is commonly used for data acquisition, instrument control, analysis and presentation of data and industrial automation on a variety of operating systems .

In LabVIEW, we do not write program lines in a textual language like Pascal or C, Basic or Fortran. We manipulate graphic objects. These graphical objects represent both the variables of the program, as well as functions that will perform actions on these variables. LabVIEW programming is simply about designing information processing, organizing and linking variables with functions using threads. LabVIEW is dedicated to programming designed for the control of electronic instruments. With LabVIEW we build graphically software modules called "VI"instead of writing code in a textual computer language. Its programming principle is based on the graphic assembly of software modules called "Visual Instruments (" VI "). The role of a VI is to acquire data from, for example, files, the keyboard or electronic input / output cards, analyze them, and present them through graphical human-machine interfaces (still called "front face" by analogy with the front panel to control an electronic device).[7]

4.2 Operation

There are two steps: the definition of the GUI (front panel) which is the design of the user interface where we draw and place all the visual elements (controls):

- input controls of the user: button, switch, potentiometer, slider, input box of value / lists.
- program output controls : LED, graph, thermometer, text box and the block diagram that contains the execution code.

For a more functional representation, these elements can be surrounded visually in a frame, grouped in tabs, and we can associate them with free text (label).Each control used in the front panel will create a terminal object in the block diagram.

The diagram is presented in a separate window. It contains the graphical source code of the VI, it allows to perform processing on the inputs and outputs created in the front panel. The diagram window will therefore contain somehow the "source code" of the program VI.

4.3 Benefits

- **Interfacing to devices**

LabVIEW includes extensive support for interfacing to devices, instruments, camera, and other devices. Users interface to hardware by either writing direct bus commands (USB, GPIB, Serial) or using high-level, device-specific, drivers that provide native LabVIEW function nodes for controlling the device. LabVIEW includes built-in support for NI hardware platforms such as CompactDAQ and CompactRIO, with a large number of device-specific blocks for such hardware, the Measurement and Automation explorer (MAX) and Virtual Instrument Software Architecture (VISA) toolsets.

- **Code compiling**

LabVIEW includes a compiler that produces native code for the CPU platform, this aids performance. The graphical code is translated into executable machine code by interpreting the syntax and by compiling. The LabVIEW syntax is strictly enforced during the editing process and compiled into the executable machine code when requested to run or upon saving. In the latter case, the executable and the source code are merged into a single file. The executable runs with the help of the LabVIEW run-time engine, which contains some precompiled code to perform common tasks that are defined by the G language. The run-time engine reduces compiling time and provides a consistent interface to various operating systems, graphic systems, hardware components.

- **Large libraries**

Many libraries with a large number of functions for data acquisition, signal generation, mathematics, statistics, signal conditioning, analysis…etc, along with numerous for functions such as integration, filters, and other specialized abilities usually associated with data capture from hardware sensors is enormous. In addition, LabVIEW includes a text-based programming component named Math Script with added functions for signal processing, analysis, and

mathematics. Math Script can be integrated with graphical programming using script nodes and uses a syntax that is compatible generally with MATLAB.

- **Easy to handle the interfaces**

  - Block Diagram

Block diagram objects include terminals, subsist, functions, constants, structures, and wires, which transfer data among other block diagram objects.

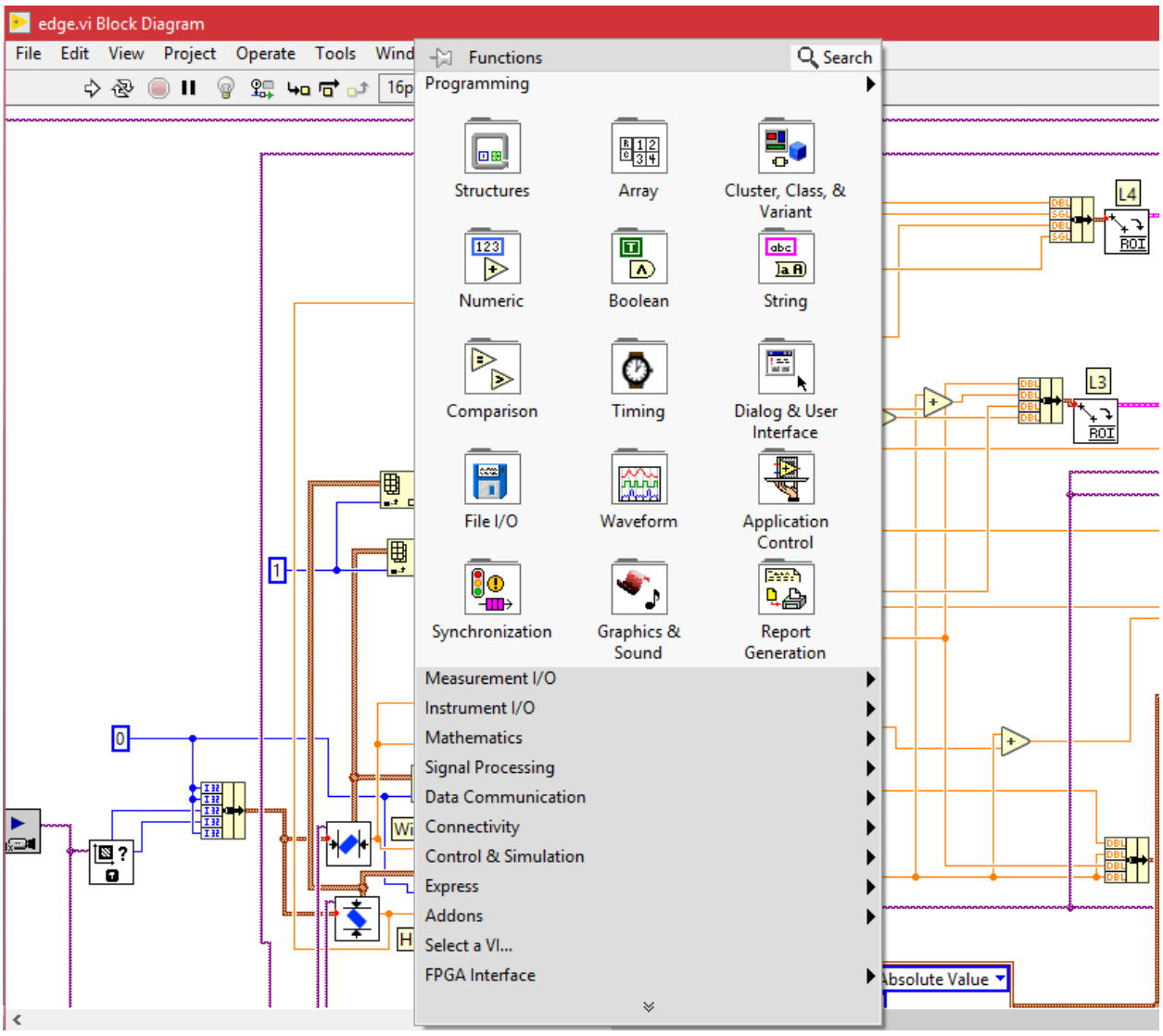


Figure 4. 1 Block diagram

- Front Panel : which the output of the processing viewed in this panel .

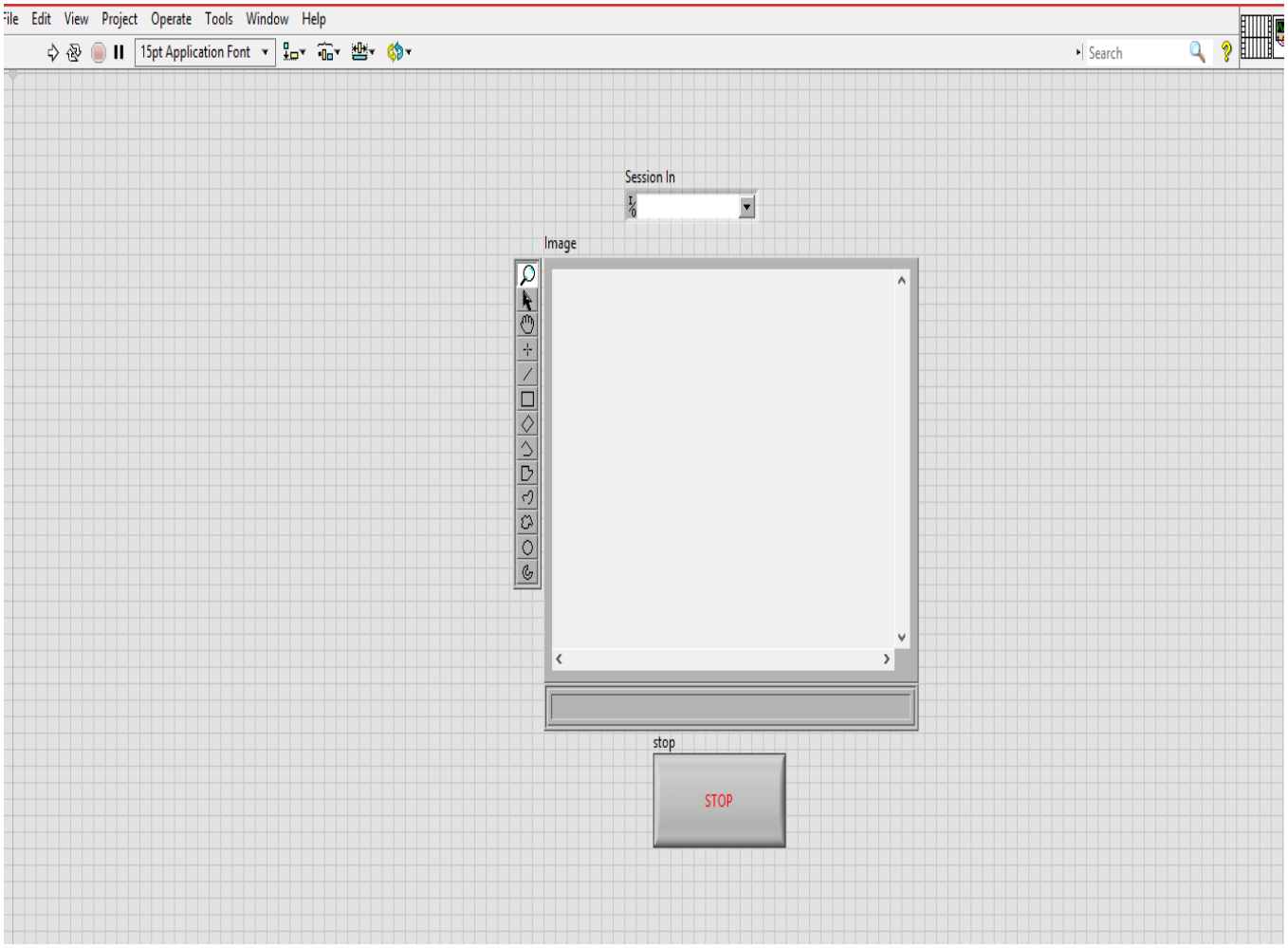


Figure 4.2 Front panel

- **Image Processing tools**

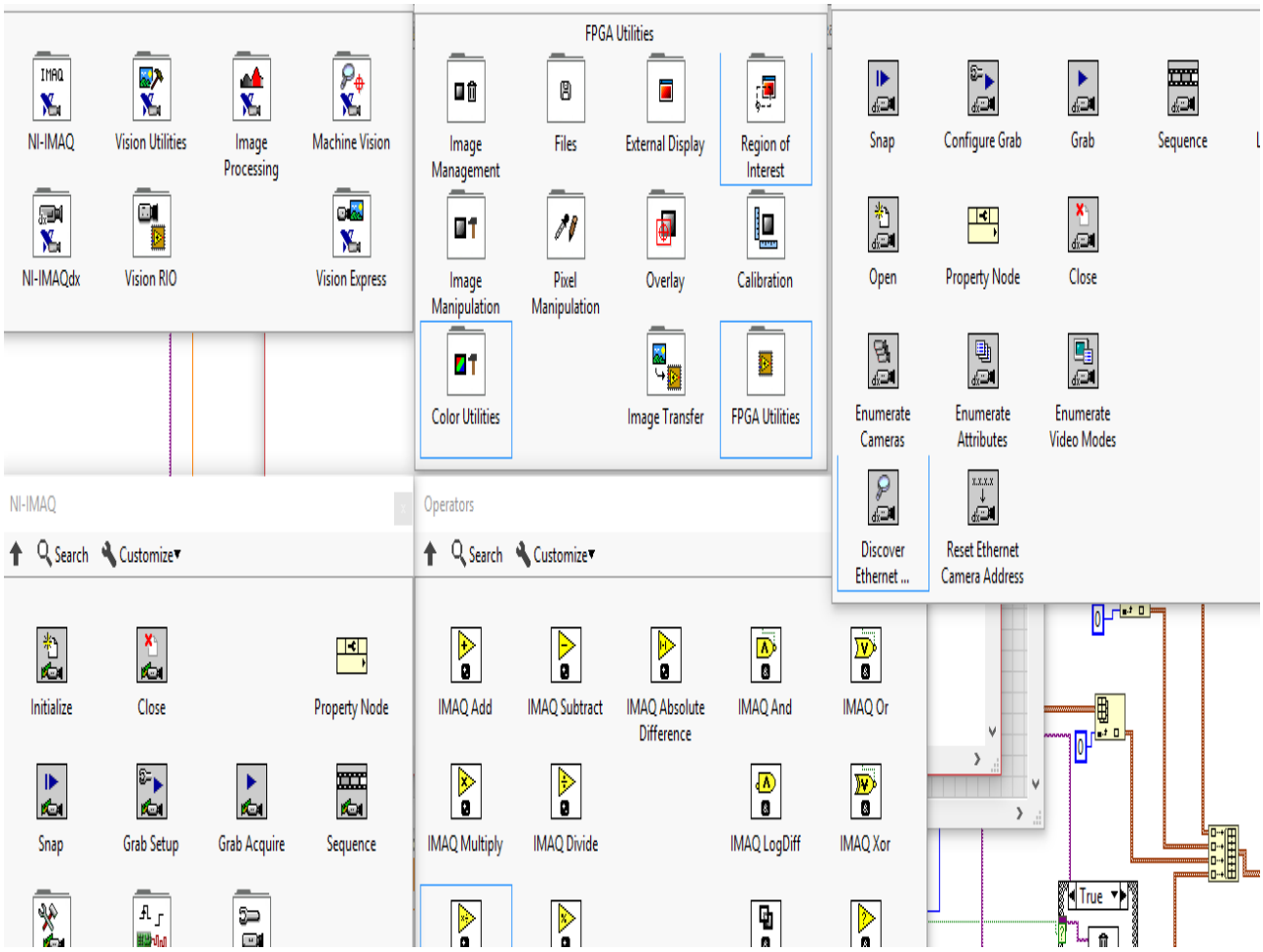


Figure 4. 3processing tools

4.4 NI Vision Development Module

1. Image Analysis

Image analysis combines techniques that compute statistics and measurements based on the gray-level intensities of the image pixels. You can use the image analysis functions to determine whether the image quality is good enough for your inspection task. You can also analyze an image to understand its content and to decide which type of inspection tools to use to handle your application. Image analysis functions also provide measurements you can use to perform basic inspection tasks such as presence or absence verification.

Common tools you can use for image analysis and processing:

- IMAQ :

 (IMAQ Read File)→Reads an image file. The file format can be a standard format or a nonstandard format known to the user. In all cases, the read pixels are converted automatically into the image type passed by Image.

 (IMAQ Get image size) → Gives information regarding the size (resolution) of the image.

 (IMAQ Clamp Vertical Max) →Measures a distance in the horizontal direction, from the vertical sides of the search area towards the center of the search area. This tool locates edges along a set of parallel search lines. The edges are determined based on their contrast and slope.

 (IMAQ Clamp Horizontal Max) → Measures a distance in the vertical direction, from the horizontal sides of the search area towards the center of the search area. This tool locates edges along a set of parallel search lines. The edges are determined based on their contrast and slope.

 (IMAQ Extract Single Color Plane)→Extracts a single plane from a color image.

 (Store Edges Results) → Stores the matches found of the edges.

 (IMAQ Simple Edge)→ Finds step edges along an array of pixel coordinates. This tool can return the first, both the first and the last, or all the edges found.

 (IMAQ ROIProfile) → Calculates the profile of the pixels along the boundary of an ROI descriptor. This VI returns a data type that is compatible with a LabVIEW graph. This VI also returns other information such as pixel statistics and the coordinates of the pixels along the ROI boundary.

2. Image processing

Using the information you gathered from analyzing your image acquire a digital image in RGB and grayscale format using the IMAQ toolbox. In this case there are two important blocks: The first one is the IMAQ Create block located in Vision and Motion, this block creates a new image with a specified image type (RGB, Grayscale, HSL, etc.), the second block is the IMAQ Read Image which is located in Vision and Motion/Vision Utilities/Files/, the function of this block is to open an image file which is specified previously in the file path of the block and put all the information of this opened image in the new image created by IMAQ Create. After loading image from computer by using IMAQ Read File tool , then getting the information of the image size and resolution to not lose the useful data of the size of image by using IMAQ Get Image size tool. Grayscale images are the simplest to consider, and are the type most frequently used in LabVIEW , and using a grayscale method to do the following :

- Filter or smooth the pixel intensities of an image.
- Alter the shape of regions by expanding bright areas at the expense of dark areas and vice versa.
- Remove or enhance isolated features, such as bright pixels on a dark background.
- Smooth gradually varying patterns and increase the contrast in boundary areas.

So we apply the luminance color plane on an image to start searching for defects.

An edge is a significant change in the grayscale values between adjacent pixels in an image. You can use the location of the edge to make measurements, such as the width , and the height of the parts. You can use multiple edge locations to compute such measurements as intersection points and projections. IMAQ Clamp Horizontal tool as we consider its used to measures a distance in the vertical direction, from the horizontal sides of the search area towards the center of the area, and search for the first and last edges along a searched area. This tool locates edges along a set of parallel search lines. See fig(4.4). While the Clamp Vertical tool is used to measures a distance in the horizontal direction, from the vertical sides of the search area to find the vertical edges. See fig(4.5)

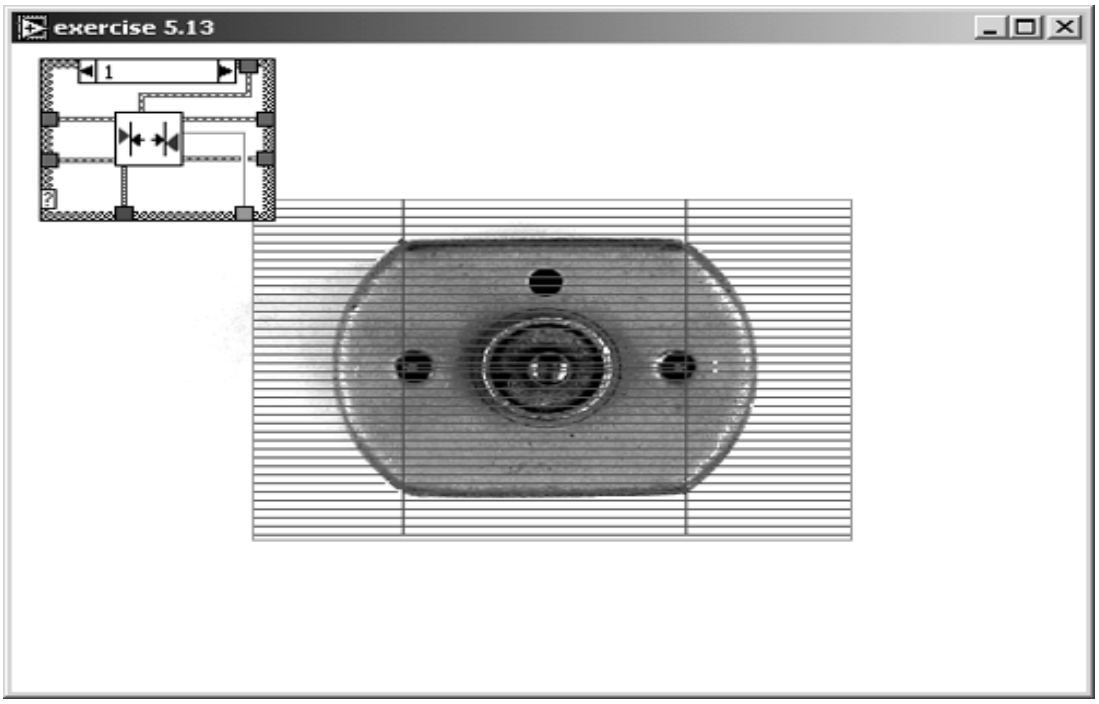


Figure 4.4 Clamp Horizontal

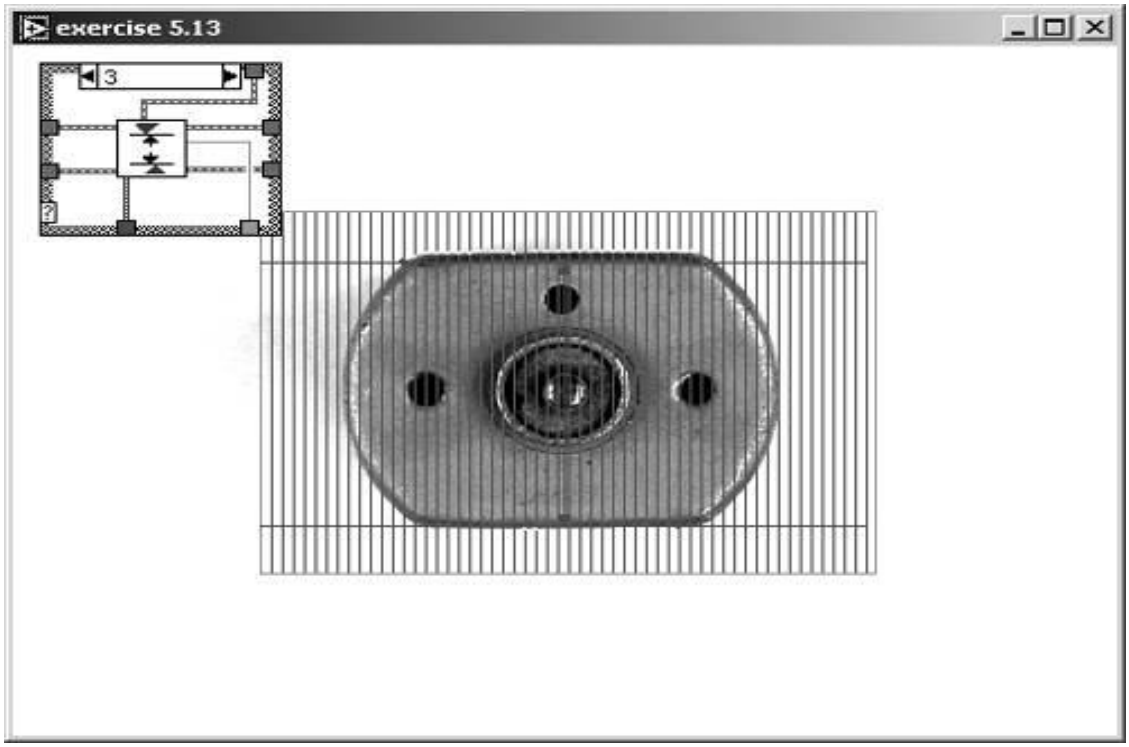


Figure 4.5 Clamp Vertical

Edge detection is an effective tool for many machine vision applications. Edge detection provides your application with information about the location of the boundaries of objects and the presence of discontinuities, the objective of detection applications is to determine if a part is present or absent using line profiles to count the number of edges along the line profile and compare the result to an expected number of edges, and because the chassis has too many edges we use IMAQ ROIProfile and calculates the profile of the pixels along the boundary that taken from clamp processing, and every region in chassis viewed as a line profile then use a convert line to region tool to use simple edge detection to locate the regions of crack using a specific value of threshold level, by this way can detect the region of cracks occur in chassis.

CHAPTER 5

Working Procedures

Working Procedures

5.1 Introduction

This project aims to improve vehicle frame inspection using automated method. This method has three main ways, left the vehicle, vision system, and LabVIEW.

After lifting the vehicle, the vision system will take a frame's picture of vehicle which we want to check it. Then insert it into LabVIEW software, after that the software will make an image processing on the image and locate the region of the crack if found .From this information we can decide if the vehicle can run on the road or should be taken down of road.

5.2 Inspection procedures

5.2.1 Lifting Vehicle

In this step of project the vehicle lifted by the jack and take into consideration the height of the car that should be taken, and it depends on vehicle wheelbase. Then the frame will be stripping from all barriers blocking or could affect the process of the maintenance check.

Figure 5. 1 Lifter

5.2.2 Light enhancement

The main purpose of the lighting is to clarify and show the details of the edges in the frame with more precision.

The light source should be placed under the vehicle in the middle of the vehicle alongside the camera. This location of the light allows to cover all the frame structure.

5.2.3 Vision system

The camera captures a picture of the frame. The camera should be with a certain specifications and high quality to show all details of the frame and edges that will use in the image process. The camera must be located on a flat surface to take a full picture of the frame. Then the picture will be transfer to LabVIEW software to process it.

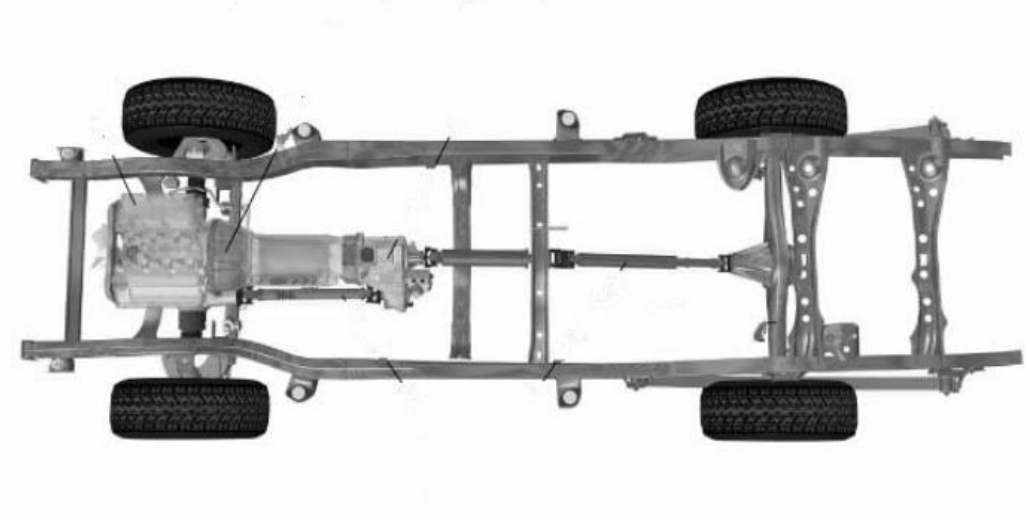


Figure 5. 2 Vehicle Chassis

5.3 Operation method

The processes of the image done through many procedures to have the final output ,as shown in the figure :

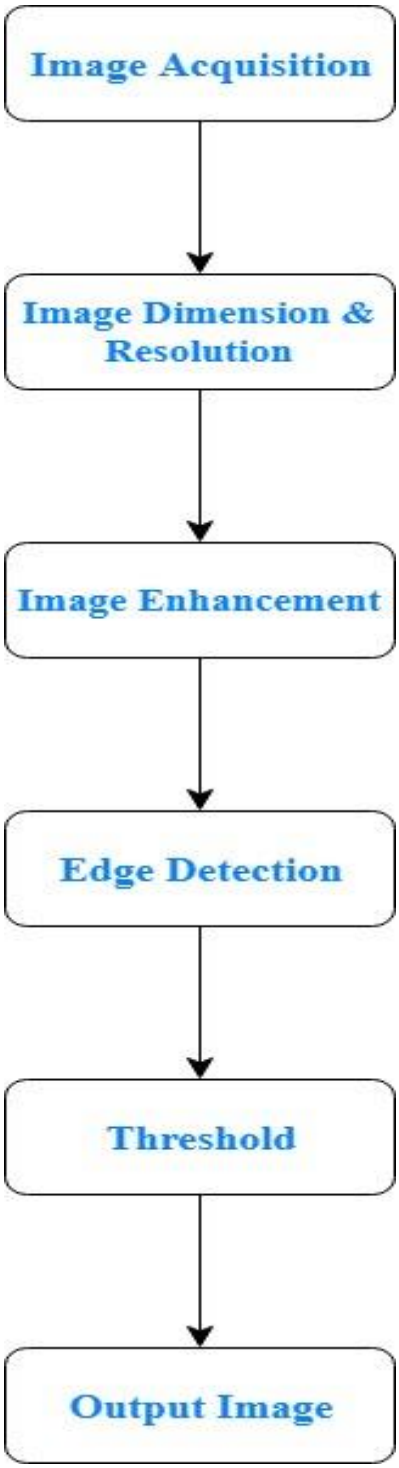


Figure 5.3 Operation Method Steps

5.3.1 Image Acquisition

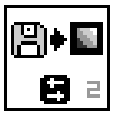
As the first step in the image handling procedure, this is a very critical and crucial stage. Since the image has to be adequately good in order to increase the accuracy of the image processing later. Thus, the image acquisition should be achieved using an HD camera and under fine circumstances. So, in order to accomplish that, we used a 13 megapixel with an external light source of 100w.

Moreover, additional camera configuration has to be set before capturing the image itself. For a starter, the image should be taken under RGB color model. This is a significant step in our case since further image modifications will be applied in order to get the final output, and some of these modifications will directly rely on the coloring model of the image itself.

In addition to RGB color model, the image will be saved as a jpeg (Joint Photographic Experts Group) format, which is the most common format across the world. This kind of format is optimized for photographs and can achieve astonishing compression rations while maintaining a very high quality.

Finally, and after capturing a satisfactory image that will be valid for further processing, the image should be transferred to the computer using a memory card.

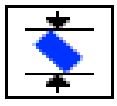
5.3.2 Image Reading



Once the image is captured and transferred to the PC, the second stage of the procedure starts, which is image reading. The image will be read from the LabVIEW using the IMAQ Read File tool. This tool is capable of reading various types of images including BMP, TIFF, JPEG, and others. Once the image is read, the tool will preserve a data space in the memory and parse the input image into 2D matrix that is loaded as pixels into the memory. Each of these pixels represents the intensity value of the image itself, or the actual color in case of our RGB image.

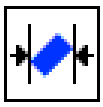
5.3.3 Image Dimension And Resolution

In this stage, we collect some metadata about the image before starting the actual processing of the image. The first thing to start with in this phase is to find the resolution of the image. This will be done by using the LabVIEW integrated tool IMAQ Image Size , which takes in the image as an input and gives the resolution as an output.



After that, we need to find the actual dimensions of the image. To do that, we use two tools from the LabVIEW. First, the horizontal clamp which measures the distance in a horizontal direction from the vertical sides towards the center.

The second tool is the vertical clamp which does the exact same work but in a vertical direction.



5.3.4 Image enhancement

The most important pre-processing step is to handle the intense light in the image. As the image brightness should be unified across the pixels as could as possible to avoid any bias results in the final output. In order to achieve that, we are used the IMAQ Extract Single Color Plane toolkit which depends on the HSL (Hue, Saturation, Lightness) luminance filter.

As we mentioned earlier in the image acquisition phase, the light circumstances are very significant as they directly affect the output of this phase. We used the luminance filter in this phase as it gives the best results when it comes to unifying the brightness among the pixels of the images in comparison to other filters. The output of this filter is a gray scale image that is necessary to do further image processing, especially when it comes to the edge detection techniques.

The gray scale image is one in which the value of each pixel is a single sample representing only an amount of light, that is, it carries only intensity information. Images of this sort, also known as black-and-white or monochrome, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest.

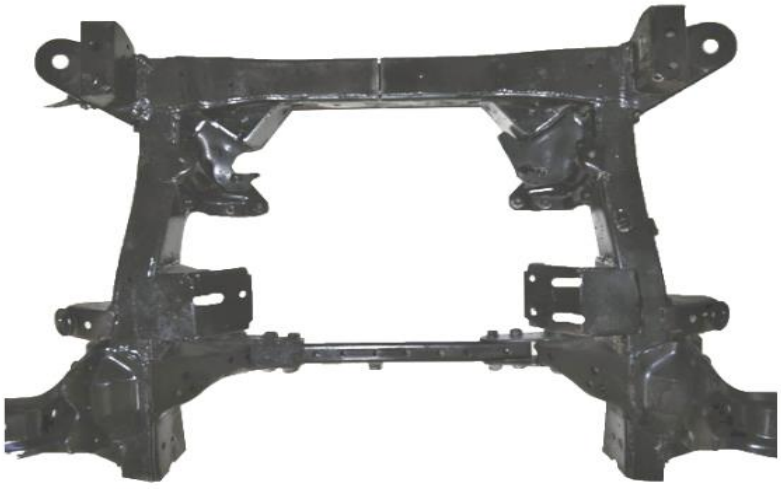


Figure 5.4Luminance Image

5.3.5 Edge Detection

In this phase, we are going to use a classical image technique that relies on finding the edges in the image by calculating the first-order derivation and second-order derivation then searching for the local directional edges.

The NI Vision offers two ways to perform edge detection. Both methods compute the edge strength at each pixel along the line profile. An edge occurs when the edge strength is greater than a minimum strength. Additional checks find the correct location of the edge.

You can specify the minimum strength by using the minimum edge strength or threshold level parameter in the software. So, to detect the region of the crack in the chassis we decided to use the simple edge detection which uses the pixel value at any point along the pixel profile to define the edge strength at that point. To locate an edge point, the software scans the pixel profile pixel by pixel from the beginning to the end. A rising edge is detected at the first point at which the pixel value is greater than a threshold value plus a hysteresis value. Set this threshold value to define the minimum edge strength required for qualifying edges. Use the hysteresis value to declare different edge strengths for the rising and falling edges. When a rising edge is detected, the software looks for a falling edge. A falling edge is detected when the pixel value falls below the specified threshold value. This process is repeated until the end of the pixel profile. The first edge along the profile can be either a rising or falling edge.

The simple edge detection used in this project due to the simplicity of using and adequate to deal with the image and locate the crack and its working with the absolute threshold. By this method the location of crack region in the chassis will found.

5.3.6 Threshold & Hysteresis

The last step in the image processing procedure is to use thresholding processing technique. Basically, thresholding consists of segmenting an image into two regions: a particle region and a background region. In its most simple form, this process works by setting to white all pixels that belong to a gray-level interval, called the threshold interval, and setting all other pixels in the image to black. The resulting image is referred to as a binary image. For color images, three thresholds must be specified, one for each color component. And is a process of converting a grayscale input image to a bi-level image by using an optimal threshold.

The purpose of thresholding is to extract those pixels from some image which represent an object (either text or other line image data such as graphs, maps). Though the information is binary the pixels represent a range of intensities. Thus, the objective of binarization is to mark pixels that belong to true foreground regions with a single intensity and background regions with different intensities.

Hysteresis on the other side basically consists of determining a high threshold that allows a group of pixels to be classified as edge points without using connectivity information among them. A low threshold then determines which group of pixels will not be edge points and permits only those points that increment the connectivity of the previously determined edge points to be aggregated as edge points.

The threshold value used in the project was 80 for the high threshold and 50 for the low threshold. The method used is absolute threshold which have a specific value depends on it and any value above the value considered as an edge.

5.4 Output Result

After doing all procedures, the LabVIEW will view the final result of the image processing as an image that have the location of crack region of the chassis if found and draw a frame around the crack as shown in (Fig 5.4)

Figure 5.5TheOutput Image

5.5 Chassis Inspection Flowchart

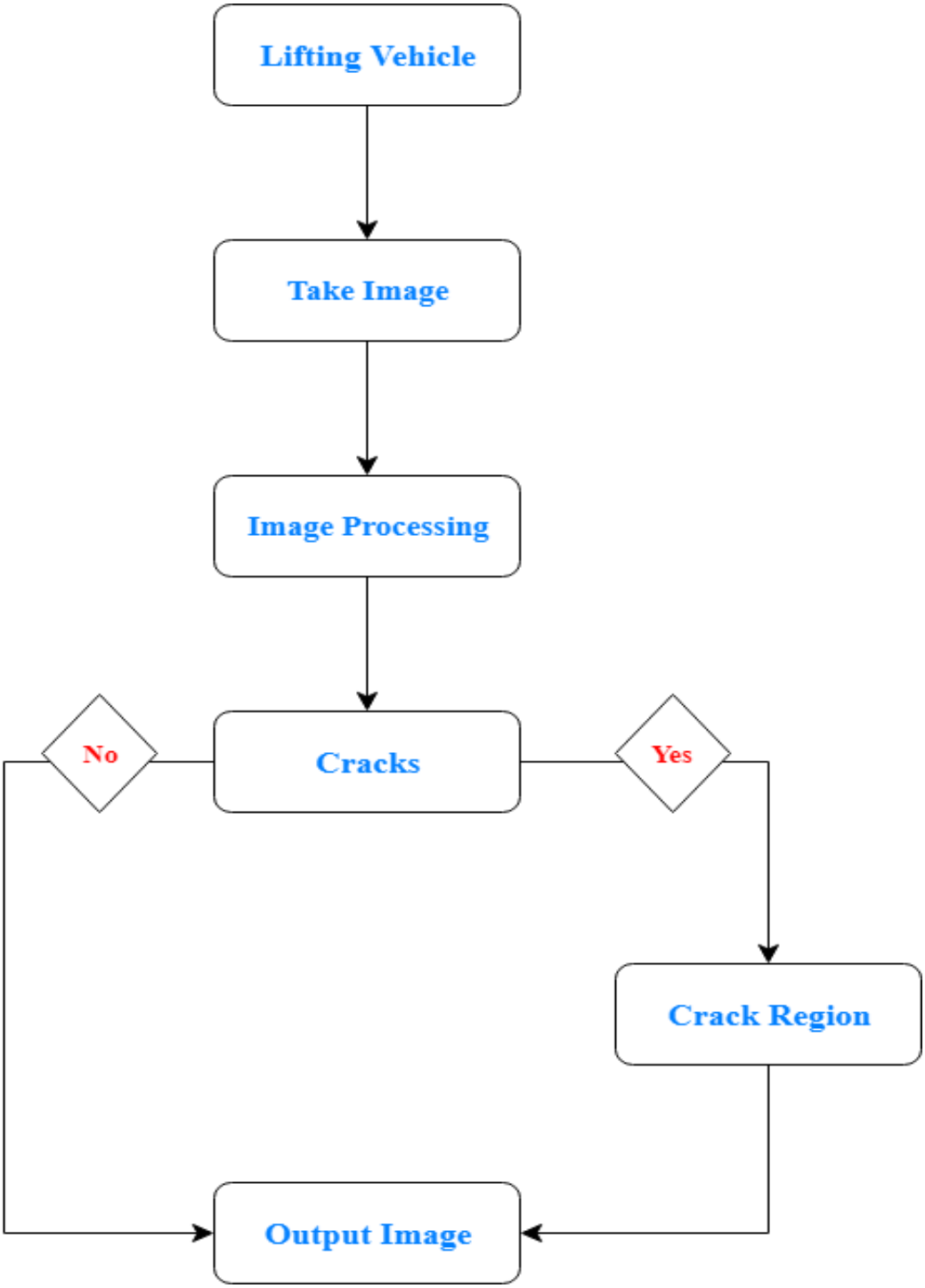


Figure 5.6 Chassis Inspection Flowchart

5.6 Problems Encountered

Every project will face multiple problems, we encountered many problems related to the lightness which is necessary in capturing the image. Since the chassis parts were have difference in intensity of lightness which affect on the clarity of chassis edges. So the luminance filter used in the project to convert the image from RGB to Grayscale to get rid of the lightness variation problem.

The second problem was in using the algorithm to find edges. So when we used the Golden Template and Map Defect algorithms we faced a problems because we have a difference width of the chassis parts and difference in the image size. So the algorithms will assume the difference in size and width as a crack. Due to these reasons we decided to use the Simple Edge Detection algorithm.

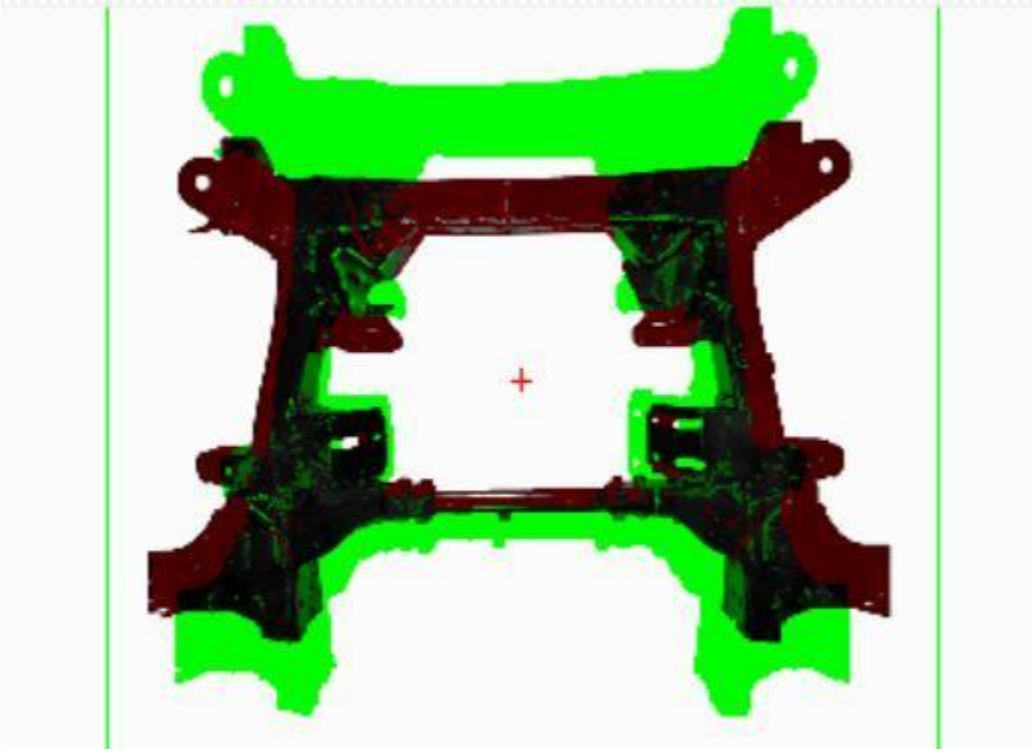


Figure 5.7 Golden Template Error

5.7 Conclusion

The method of testing chassis frame is very important and its one of the most important problems in vehicle, this project make the chassis test easier than the conventional method since the tester faces a lot of difficulties in checking the chassis with Inaccurate data. So, by using LabVIEW software program can detect the cracks location of the chassis using image processing algorithms.

The process of the project will be done by taking the image of the vehicle frame and then insert it to the computer, after that take the image to LabVIEW program and it will start it's processing to detect the cracks location if found. The crack regions will appear in the original image with a pointer around the crack.

Finally, the project will help to reduce time and effort required to decide whether the vehicle is safe and if the vehicle needs the universal standards of safety for its own chassis. Which insures drivers and passenger's safety on the roads.

❖ References

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