**Palestine Polytechnic University**

**College of IT and Computer Engineering**

**Department of Computer Engineering**

**Introduction to Graduation Project**

**Project Name**

# Intelligent Traffic Light Guidance System (ITLGS)


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**This document is submitted in partial fulfillment to the requirements of the projects of Graduation, within the B.Sc degree in *computer system engineering.***

**Hebron-Palestine**

**May-2015**

## Abstract

Road traffic congestion continues to remain a serious problem in most cities around the world, especially in the developing countries. It usually occurs in small critical areas that represent city centers and roads intersections. This problem is a result of inappropriate planning for road networks, increasing number of vehicles and poor traffic management. The congestion leads to unnecessary delay, noise, fuel wastage and loss of money. In addition accidents rate may increase. the aim of this project is to build an embedded system based on image processing and machine learning techniques to develop an algorithm that can detect the road traffic congestion levels in Ain Sarah Street. This algorithm will receive live images from a camera placed on the street and analyse it using a microcontroller. Congestion level and guide sign will be displayed on an optimal traffic light sign. The system is feasible since building the model is inexpensive and it can be easily installed.

## Acknowledgement

In the beginning we thank Allah for giving us the ability to complete this project despite all the difficulties and challenges that we faced during the year.

We would like to thank our supervisor Dr. Radwan Tahboub who stood with us and was generous enough to give us the support we needed to complete this project successfully.

We also thank all of the instructors in college of IT and Computer Engineering for their great effort and support during all of these years.

We also thank the deanship of graduate studies and scientific research of funding our project with 400 JD, and for supporting us continuously.

We must not forget to acknowledge Palestine Polytechnic University for giving us this great opportunity and for embracing us during the whole five years.

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# Chapter 1

# Introduction

This chapter presents an overview about the project idea, motivations, objectives, importance of the project. It also contain problem statement, problem analysis, definition, requirements and expected results.

## 1.1 Overview

Due to the limited infrastructure in the existing roads and the increasing number of vehicles moving in public roads, traffic congestion become a serious problem by time. Therefore we need to do something to reduce this problem.

So we thought of ITLGS to minimize the effects of this problem. The idea of this project is to guide drivers to streets with less congestion before they get stuck. This can be achieved through a special traffic light that shows whether the street is congested and the proportion of congestion. the process starts with a snapshots for the related streets sent to the microcontroller. It will analyses the conditions of the traffic in the streets, deciding which one is less congested. Then accordingly the system will light the appropriate signs to guide the drivers into the free or less congested roads.

The guidance signal in the figure shows the percent of congestion and the arrow represent the condition of the road, when it is red it means there is congestion otherwise it mean it is free. Before the driver enter the street, he/she sees the guidance sign, makes decision which road to go away from congested ones. Figure 1.1 shows a congested street and the expected result of the project.

Figure 1.1: Congestion of Ain Sarah Street.

## 1.2 Motivations

This project could be a good solution to the traffic congestions problem. It also can provide many benefits to people. These benefits formulate our motivations to implement this project.

The benefits are:

1. Save time and effort for drivers.

2. Facilitate the emergency vehicles motion, (i.e. ambulance, police).

3. Reduce the noise traffic jams.

4. Minimize air pollution by reducing the harmful gas emitted from vehicles in a limited area as a result of traffic jams.

5. To decrease and save consumed power and maintenance costs for vehicles.

## 1.3 Project importance

this project deals with a serious problem, traffic congestion, which all community suffer from it. In an attempt to reduce the problem, this will save people time, effort and people's lives. Implementing such a project will let people arrive their destinations with least time and power consuming. Also, warning ambulance drivers from crowded streets could save patients alive. This project is implemented for the first time in our society, with low implementation and construction costs, and do not need special conditions or constraints to be constructed. Therefore it is easily can be installed in society streets.

## 1.4 Objectives

The proposed project aims at:

1. Enable drivers to choose the most appropriate path before reaching the congested roads, by providing them with the current condition of the roads.

2. Handling the daily traffic congestion.

3. Design and develop a practical system with modern technologies, which is beneficial to individual in particular and society in general.

4. Warn the drivers if there is an accident at the end of a road or at an intersection.

5. Detect the congestion using machine learning and image processing, images taken by still cameras on roads.

6. Design, install and test the system in a real intersection under different conditions.

## 1.5 Problem Statement

Traffic congestion continue to remain a major problem in most cities around the world. It occurs when vehicles flow is greater than the road capacity. It is recognized from long queue of vehicles which lead to slower speed and longer trip time.

Traffic congestion caused by increasing number of vehicles, Due to economy and technological development and population, these all against the limited resources and the poorly planned roads. In addition poor traffic management, drivers who are not trained sufficiently to follow lane discipline and do not follow traffic laws, those could cause accidents and then one or more streets will be blocked.

Many solutions have been proposed to deal with congestion, one of them is cellphones technology, which is used greatly to determine which routes are the most congested, where it sends messages to the drivers to change routes depending on the data that the system collects [1]. Also some people use mobile applications that shows road conditions depends on the other users views. Another solution is to use alternative forms of transportation instead of private vehicles, such as public transports, metro and bicycles.

But the first two solutions need internet connection in order to work well, and as for the last one; some people do not easily accept it because some of them think of these transports is for lower echelons of society.

To solve the previous problems a smart flow control techniques will be used to distribute cars in the targeted roads to reduce the congestion. Road traffic jams in Ain Sarah streets is one of the major problems that people who live in Hebron suffer from. Until now no solution has enough advantages to replace the traffic jams. In this system microcontroller, cameras, image processing, machine learning and light signs will be used to create an intelligent system that will guide the drivers into the less congested road in Ain Sarah streets.

### 1.5.1 Requirements

The proposed project will:

1. The cameras will take snapshots for streets continuously.
2. Analyze the images using microcontroller and determine the street status.
3. Light the signs accordingly for drivers to go through other roads. We assume that the other roads is always free or less congested.

### 1.5.2 Expected Result

Build an intelligent system that can detect congested streets and guide vehicles to go away from them. Our project, "Intelligent Traffic Light Guidance System" is embedded system with camera and light signs to manage the congestion in Ain Sarah Street, should reduce the traffic congestion.

# Chapter 2

# Background

This chapter talks about theoretical background, literature review that are related to the main idea of the ITLGS project and the system components.

## 2.1 Theoretical Background

### 2.1.1 Image Processing

The image is an array, or matrix, of pixels (picture elements) arranged in rows and columns. This image contains a large amount of information that can be processed using image processing technique. Main types of images is:

1. Binary image (black and white).

2. Gray scale image, the range of image type shade between black and white (0-255) that is different gray levels.

3. Colored image: there is many color models for image, for example RGB model and HSV model.

#### 2.1.1.1 Color models

1. HSV model: related to "hue-saturation-value", it is another way to represent a colored image. It is cylindrical geometries. Where hue represents, on the angular dimension, the color of a pixel start from red, passes through green to reach blue, and finally wraps back to red. Value, horizontal dimension, represents the lightness ,it starts from white on the top of the cylinder go through gray ranges to reach black on the bottom. Finally there is Saturation on the vertical represents

the fullness of a color in a pixel [2]. The full representation is shown in the figure 2.1.

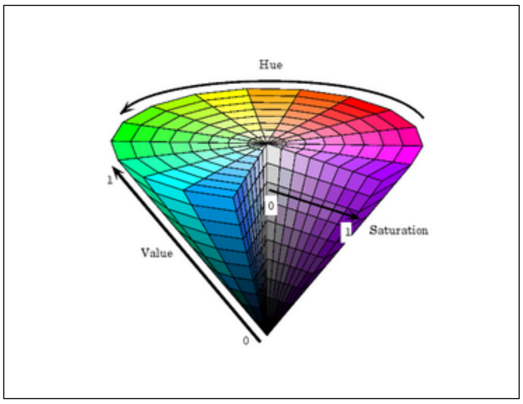



Figure 2.1: HSV color model [2].

The equations used to convert an image from RGB to HSV is as shown :

$$R' = R/255. \tag{2.1}$$

$$G' = G/255. \tag{2.2}$$

$$B' = B/255. \tag{2.3}$$

$$Cmax = max(R', G', B'). \tag{2.4}$$

$$Cmin = min(R', G', B'). \tag{2.5}$$

$$\Delta = Cmax - Cmin. \tag{2.6}$$

Hue calculation:

$$H = \begin{cases} 0^\circ & \Delta = 0 \\ 60^\circ \times (\frac{G'-B'}{\Delta} mod 6) & , C_{max} = R' \\ 60^\circ \times (\frac{B'-R'}{\Delta} + 2) & , C_{max} = G' \\ 60^\circ \times (\frac{R'-G'}{\Delta} + 4) & , C_{max} = B' \end{cases}$$

Saturation calculation:

$$S = \begin{cases} 0 & , C_{max} = 0 \\ \frac{\Delta}{C_{max}} & , C_{max} \neq 0 \end{cases}$$

Value calculation:

$$V = Cmax$$

2. RGB model: related to (Red, Green, Blue), it is primary simulate the human color perception, where each color defined by giving the intensity level of red, green and blue light that mixed together. With most of today's displays, the intensity of each color can vary from 0 to 255, which gives 16,777,216 different colors [3].

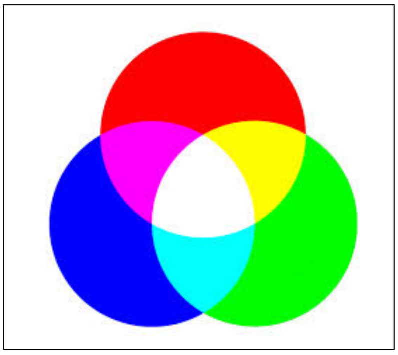


Figure 2.2: RGB color model [3].

figure 2.2 shows RGB color representation.

#### 2.1.1.2 Image Processing algorithms

Algorithms may use in this project:

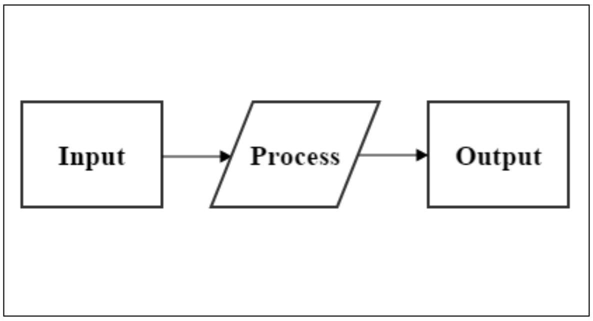
1. Histogram: is a chart that shows the distribution of intensities in an image. It can be used as a feature in some applications. The result is stored in an array.

2. De-noising algorithms used to get rid of unwanted pixels in the images especially that come from imperfect sensors. Mean, Median and Gaussian are examples of filters used in this case. Each filter is a matrix of numbers convoluted to each pixel in the original image.

Image processing algorithms used in order to get an enhanced image or to extract some useful information from it. In this project use the image processing mechanism for image enhancing in preprocessing stage.

### 2.1.2 Machine Learning

It is the science that concerned with the design and development of algorithms and techniques that allow computers to learn, without being explicitly programmed. The input is many instances of the problem and their expected




results( in case it is supervised learning) that used in training phase of the machine learning system. The process is one of machine learning algorithm that can solve the problem after training. The output of the algorithm is a solution that is usually not optimal, and this used in testing phase.
In the past decade, machine learning has given us self-driving cars, practical speech recognition, effective web search, and a vastly improved understanding of the human genome. Machine learning is used in cases where regular programming failed, such as problems that not defined(no mathematical model), issues related to understand biological way of learning, the data of the problem is not ready at design time or even there is noise in this data. Other problem has huge data that need to be minimized. Also in other cases speed and significance is required over precision. So we need machine learning model to solve such problem.

#### 2.1.2.1 Machine Learning Algorithms

1. Classification: Classification is the process of sorting objects into defined finite number of groups called classes, according to one or more feature. Classification based on nearest neighbors class to classify the an item or it may depend on the mean of the classes or Naive Bayes which related to the probability of the item to belong to a class. Classification is simple, powerful and do not need train time. But it need to keep all the samples for make decision so it is memory intensive. Also estimation is slow [4].

   The figure 2.3 shows a classification system depending on nearest neigh-

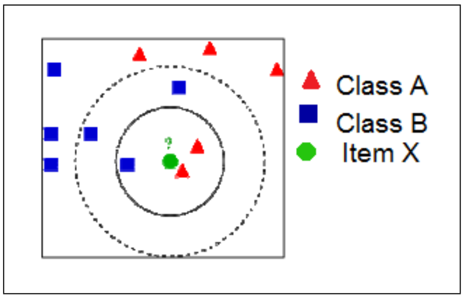



Figure 2.3: classification system [4].

bors, using 3 nearest neighbor the item X is classified to class A. Using 5 nearest neighbor the item X is classified to class B.

2. Clustering: Clustering is the process of grouping a set of objects into groups each called a cluster, each cluster contain similar objects, close to each other more than other objects in other clusters. This done by making quantitative comparisons of multiple characteristics for these objects. One algorithm used called K mean Clustering, the grouping is done by minimizing the sum of squares of distance between data and the corresponding cluster centre [5].

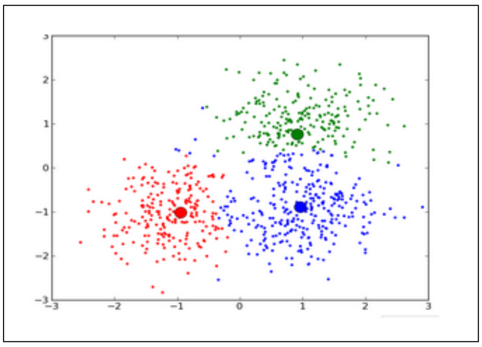


Figure 2.4: K mean clustering [5].

figure 2.4 shows clustering example using K mean clustering, where K equal three in this example. It also shows the three centers of the three clusters. Clustering may need more time in training, but it may lead for new knowledge in grouping some data.

3. Regression: the process of finding the best fitting function(curve) through a set of points, where each point represent a sample, each sample represented by number of features. It may use other methods to find the best function parameters with lowest cost, such as Gradient Descent.

The regression function may be linear, second order or any polynomial [6].

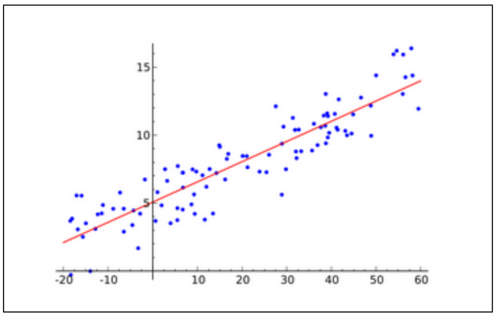



Figure 2.5: Linear regression [6].

figure 2.5 shows linear regression line for one feature data.

4. Neural Network: it is machine learning technique that is inspired from biological neural network. It used to estimate or approximate functions that can depend on large number of inputs and are generally unknown. Neural networks are generally represented as systems of interconnected neurons which can compute values from inputs to create output and pass it to next neural [7].

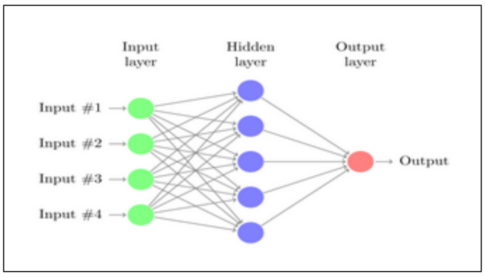



Figure 2.6: Neural network [7].

Figure 2.6 shows a neural network, contains three layers (input layer, one hidden layer and output layer) accepts five inputs with bias, and outputs one output. this project use neural networks to distinguish between images to identify the street status.

## 2.2 Components Background

### 2.2.1 Cameras

Is a visual tool that captures images that can be stored directly, or transfer to another place. These images may remain still images, or transferred into a stream of images such as video [8]. In our project, the camera will be used to take snapshots of the street continuously and transfer it to the microcontroller.

#### 2.2.1.1 CCTV camera

Closed-circuit television (CCTV), also known as video surveillance. Can be either video cameras, or digital stills cameras, normally maximum frame rate 30 frames per second for digital and resolutions of 1, 2, 3, 5 and even up to 11 Mega pixels. This System uses video cameras to transmit signal to a specific computer where they are monitored, and is distinct from broadcast television in that the signal is not transmitted in open systems. Though it may employ point to point (P2P), point to multipoint, or mesh wireless link [9].

#### 2.2.1.2 Logitech C310

The Logitech HD Webcam C310 is characterized by quickly and easily installed, works seamlessly with video chat programs and even takes high-quality 5-megapixel snapshots [10].

### 2.2.2 Microcontroller

Is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose devices [11].In our project, we will use two microcontrollers, the first one will receive images from camera continuously to be analyzed and data from the IR sensor, then transmit the decision to the second one to be displayed on LCD screen and LEDs.

#### 2.2.2.1 Raspberry Pi microcontroller

The Raspberry Pi is a low cost, of a credit-card size computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable device that enables youth with enough knowledge to explore computing. It is programmed using high level languages such as Scratch, Python and C++. It is capable of doing everything you would expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games [12]. See figure 2.1:

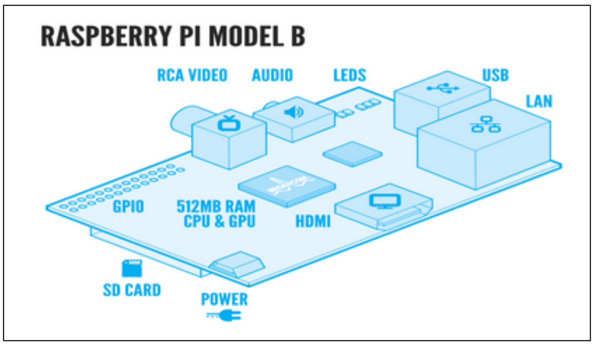



Figure 2.7: Raspberry pi schematic diagram [13].

#### 2.2.2.2 Banana Pi Microcontroller

Banana Pi is an open-source single-board computer. It can run Android 4.4, Ubuntu, Debian, Raspberry Pi Image, as well as the Cubieboard Image. It uses All Winner A20 system-on-chip (SoC) and has 1GB DDR3 SDRAM. It is the same as Raspberry Pi but it has additional features [14].

### 2.2.3 Wi-Fi Technology

It is a local area wireless technology that allows an electronic devices to exchange data or connect to the internet using 2.4 GHz UHF and 5 GHz SHF radio waves [15]. In our project, the usb Wifi dongle will be used to connect the microcontrollers together and transmit results to be displayed for drivers.

### 2.2.4 LCD screen

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits.These modules are preferred over seven segments and other multi segment LEDs. LCDs have no limitation of displaying special and even custom characters, unlike in seven segments. Also, easily programmable [16].

### 2.2.5 Power

We will use a 12 volt battery to power the system for test issues and for the camera USB will be used. For installation the municipality will use the street cables to power the system.

## 2.3 Literature Review

This section reviews the literature related to our work.

### 2.3.1 Traffic and Road Condition Monitoring System

In this paper, some of the algorithms had been used to detect traffic jams [17].

#### 2.3.1.1 Microwave RADAR

Microwave radars use specially allocated radio frequency for detecting vehicles. There are two types of microwave radar detectors. The first type uses the Doppler principle to detect vehicles. According to the Doppler principle the difference in frequency between the transmitted and received signals is proportional to the speed of the vehicle. So this type of microwave radar first transmits electromagnetic energy at a constant frequency. If the detector senses any shift in the received frequency it deduces that vehicle has passed. One major problem with this type of microwave radar is that it cannot detect stationary vehicles. The second type of microwave radar detector transmits a frequency-modulated continuous wave that varies the transmitted frequency continuously with time. This enables the system to measure the range of the vehicle from the detector. Hence, this type of microwave radar can detect stationary vehicles as well. Speed of the vehicle can be calculated by measuring the time taken by a vehicle to move between two internal markers separated by a known distance. However, even these microwave radar systems have problems such as over estimating speed and occupancy values.

#### 2.3.1.2 Infrared Detectors

Passive infrared detectors do not transmit energy but instead use an energy sensitive photon detector located at the optical focal plane to measure the infrared energy emitted by objects in the detector's field of view. Thus, when a vehicle enters the detection region of the device, it produces a change in energy, which is sensed by the photon detector. This system can only detect vehicle passage or presence. It cannot provide any information regarding speed of the vehicle. Change in weather conditions such as fog, rain, or snow results in performance degradation of these systems.

### 2.3.2 Design an Embedded Web Server for Road Traffic Monitoring

In this paper Sahar developed a system that contains two basic components: wireless sensor network (WSN) connected to embedded system web server, it collect data from vehicles and do calculations in the web server. WSN is connected to each vehicle and each street has a web page. When a vehicle enters a street, it sends special message to the web server, Then it counts number of vehicles (message) in each street and continuously it updates page of each street. User could access the streets pages and view the number of cars in each street and more data about vehicles such as speed and so on [18].

### 2.3.3 Road Traffic Congestion in the Developing World

This paper shows another technique for congestion detection that is image processing. Jain et al, used image histogram to find out whether the road is empty, depending on road color in gray scale (the value of pixels that represent road lies between 135 and 165). If this range appears heavily in the image histogram, the road is free. This technique work in day time but it does not work in dark so they used a different algorithm. In dark the used algorithm depends on the illumination emitted from cars. The algorithm transfer the street image into black/white image the white pixels represent illumination. As the density of white pixels increase that means the street is congested [19].

### 2.3.4 Traffic Congestion Management Using Wi-Fi Technology

This project use another image processing method to detect street congestion, depend on camera to take images for the street. Then in microcontroller's memory there is a default image for the empty street, this image are subtracted from each new image to get all objects (vehicles) in the street, then the result image are converted into binary image , after that segmentation algorithm is used to count the number of vehicles in the street. Depending on the number of vehicles it will decide whether the street is congested or not. The system completely powered by solar energy. The disadvantages of this process that it need a default image for every street that used in. Also if the vehicles are close to each other the system will see as one object. And it didn't take in account all environments changes that may affect the system, such as climate changes and others [20].

# Chapter 3

# System Analysis and Design

This chapter describes the system main parts and the design concepts. We will illustrate the system analysis, general block diagram, design option, System Main Component, and system functions. Figure1.1 shows the intersection that we select to apply our project in Ain Sarah Street


Figure 3.1: Ain Sarah Street

## 3.1 System analysis

Figure 3.1 shows three areas from Ain Sarah Street. In the first area we will put the camera attached to the microcontroller over the traffic light. In the third area we will put the guide light sign with congestion Level screen both connected to another microcontroller.

### 3.1.1 ITLGS Physical Component

Our system has five components mainly. A camera will take snapshots for the street every T seconds passing them to Raspberry Pi Microcontroller. Then it will perform the required processing on data to calculate congestion percentage and street condition. Then Tenda Wi-Fi transmitter/receiver will be used to transmit the resulted information to an optimal traffic light.

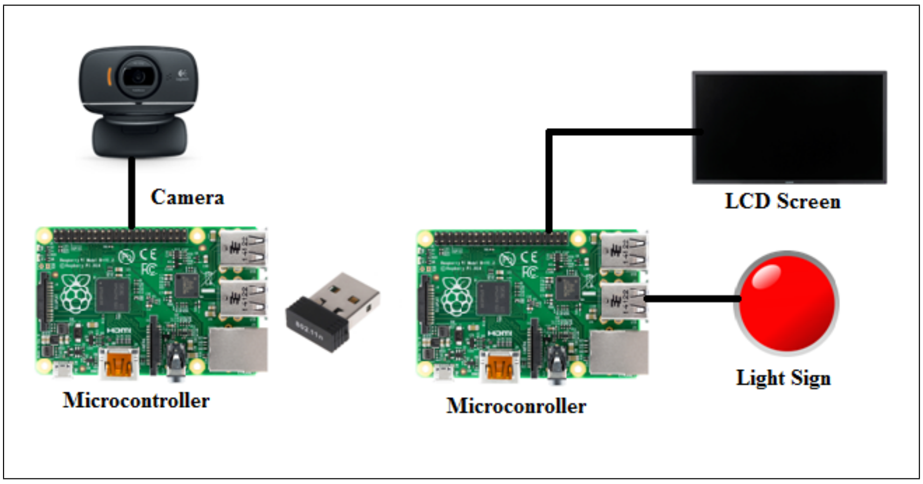



Figure 3.2: ITLGS Physical Component.

### 3.1.2 System detailed requirements

1. The Logitech C310 cameras will take snapshots for Ain Sarah Street continuously.
2. Analyze the images using the microcontroller to determine the street status and the congestion level if there is congestion.
3. Light the signs accordingly for drivers to go through other roads as shown in chapter one figure 1.1.

### 3.1.3 General Block Diagram

Presents the main components of the system are: 12 volt power supply, Logitech C310 camera, Raspberry Pi microcontroller, Wi-Fi transmitter and receivers with light sign and congestion percentage LCD screen to guide the driver if congestion occur. Figure 1.1 represents a general structure connecting the system components together.

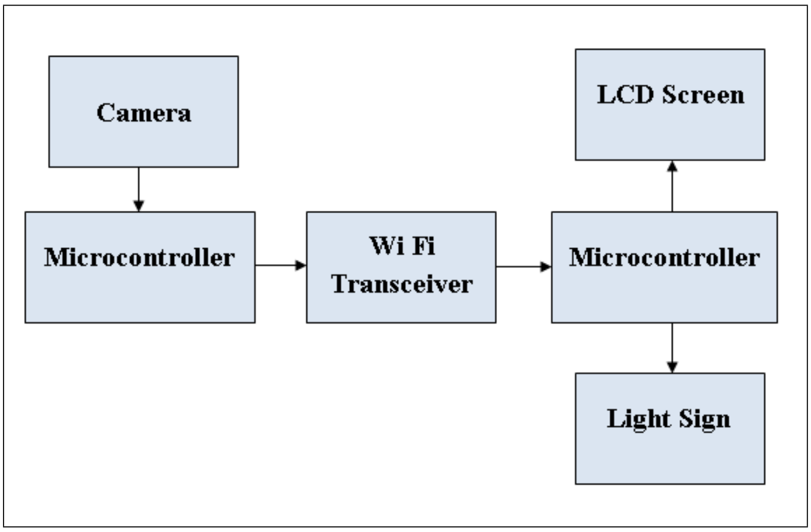



Figure 3.3: General block diagram.

1. Input data: street images.
2. Process data in the microcontroller and then transfer the result to the other microcontroller via Wifi to be displayed on the screen and the sign, and they will be updated continuously.

The system is divided into two stages:
Stage one:

1. Collect Images for Ain Sarah street in Hebron city, in different times of the day.
2. Classify these images into three classes( fully congested, half congested and almost empty).
3. Transfer images from RGB color model to HSV model. In order to reduce the effects of lightness and climate changes, only Hue dimension will be used in the next step.

4. Find the histogram of images Hue.

5. Use the histogram as input to train the neural network system using Matlab, then build the decision function of trained neural.

Stage two:
After the construction of the neural network have been done successfully the system should work as follows:

1. Pass the data from terminals to the microcontroller.

2. Do the required process on the data (convert to HSV, calculate the histogram of H)

3. Apply the decision function on image histogram, to find out its classification, taking into consideration the previous decisions to ensure the street status.

4. Determine the percentage of congestion of the street.

5. Display these results on a screen and a sign placed before the intersection.

### 3.1.4 Design Option

to implement such a project, hardware solution or software are considered (some is mentioned in previous sections). In this project software solution has been chosen. Because it is less expensive, more efficient, has less maintenance cost and can not be destroyed. Also a machine learning technique (Neural Network) are chosen, because it more efficient, decision making is simple, fast to compute and do not need storage space.

#### 3.1.4.1 Raspberry Pi

Raspberry pi microcontroller supports multimedia and has effective processing power. Also it is fast, cheap and easily connected to other components via USB. Since our project use camera and image processing, we choose it. Other microcontrollers may be selected as Arduino but it do not efficiently support our project requirement. It has less processing power, do not support multimedia and more expensive.

#### 3.1.4.2 Raspberry Pi Programming

Raspberry Pi support many programming language. This project we will use Python language because it more powerful, has readable syntax that allows you to express functions or concepts in fewer lines of code than that would be required in other languages. Also it supports multiple programming paradigms including imperative, functional and object oriented styles, allowing a wide range of tasks to be performed.

#### 3.1.4.3 HSV Color Model

We avoid using value in HSV image in train the network to be more general, since it reflect the lightness effects. Figure 3.4 .a represent histogram of Hue of three random images, one from each class. And figure 3.4.b is the same but for HS together. We notice that using HS the histogram has almost the same behaviour for the three classes. But using H the histogram has different behaviour in each class, so it is better for train the network and easy to find the differences between classes.

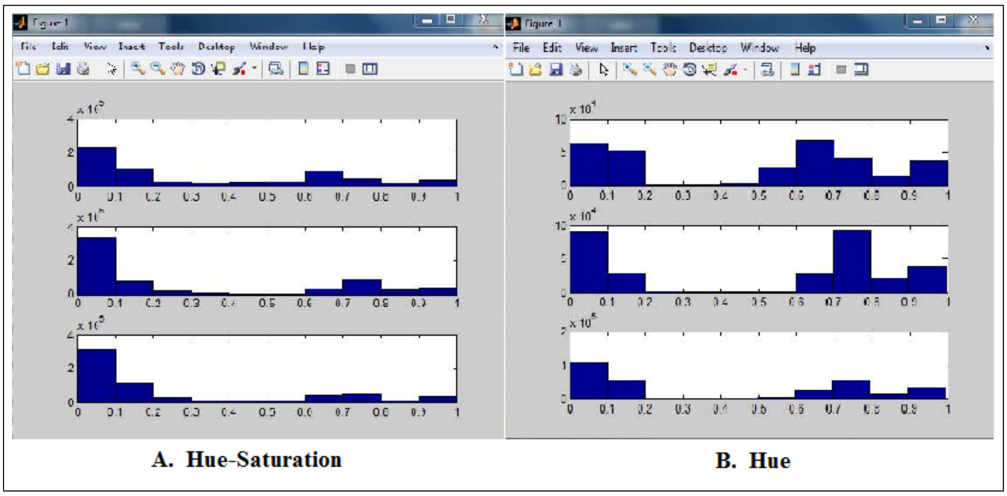



Figure 3.4: histogram for random image from each class.

# Chapter 4

# Software and Hardware Implementation

## 4.1 Introduction

This chapter describes the hardware and software implementation of the system.

### 4.1.1 Software Implementation

The software of the system have been developed mainly in three stages:

1. Neural network training using Matlab: this stage goes through several steps to generate the function of neural network.

2. Decision making in Raspberry Pi via Octave: this stage describe general steps for decision making using the previous neural network parameters.

3. Display the decision in the LCD and light singe using Python: this stage will display appropriate percentage of congestion and light the singe according the received information.

Here is the details of each stage:

1. Neural network training using Matlab: It starts with feature extracting from images, then build the neural network using "newff" Matlab function, and pass the features to it. Then train the neural, using "train" function, and build a proper function using results of trained network ( weights and bias for each neuron).

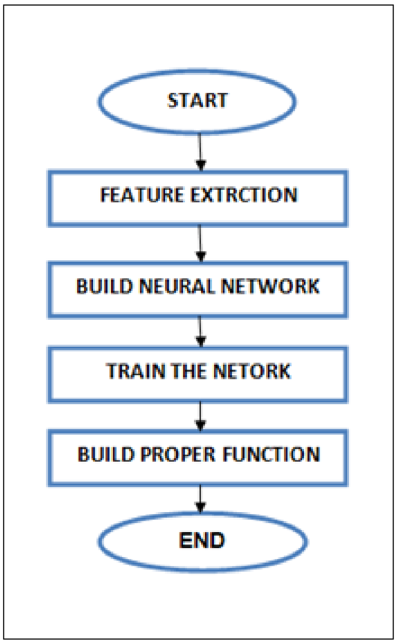



Figure 4.1: Neural network training flowchart.

Pseudo code for feature extraction:

**Input classified images file;**
**Num_Of_Bin s = 20;**
**For each image in the file.**
**New_Image = rgb2hsv(image);** *//convert to HSV model.*
**Hue = (extract the hue component from image)**
**Hue_Hist = hist(Hue, Num_Of_Bins);**
**Total_Hist = [ Total_Hist Hue_Hist];** *// concatenate hue of current image with the previous images hue.*
**End for**

We built artificial neural network that has 3 layers (input layer, layer 2, output layer). The second layer has four hidden layers and the output layer has three neurons.

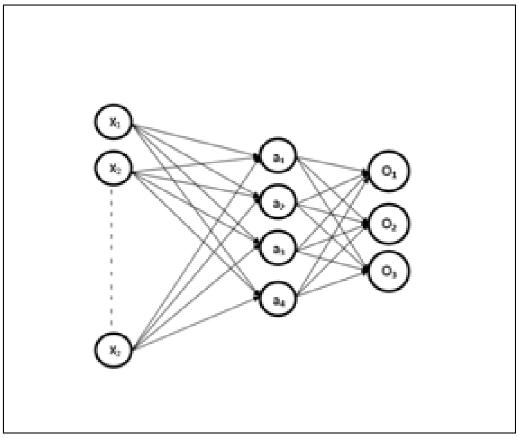


Figure 4.2: Neural network.

Pseudo code for build and train the network:

**Data = Total_Hist;** *// from feature extracting step.*
**Target = Images_Class;** *// images classes in binary representation (001,010,100).*
**Num_Of_Hidden_Layers = 4;**
**Net = newff(Data, Target, Num_Of_Hidden_Layers);**
**Net = train(Net, Data, Target);**

Neural network function:
It is a relation between the input and weights for each neuron, this relation is described as follow:
Let,
**histImg,** be histogram of hue component of an image,
**N_WL,** be the weights matrix for the second layer.
**N_WI,** be the weights vector for the output layer.
**N_B1,** be bias for the hidden layers.
**N_B2,** be bias for the output layer.

Then the function is:

```
Temp = (N_B1 + N_WI *histImg');

Y = N_B2 + N_WL* temp;
```

2. Decision making: This stage describe code implementation for the first Raspberry Pi, which analyze street situation according to the images from the camera. Figure 4.3 decision making flowchart.

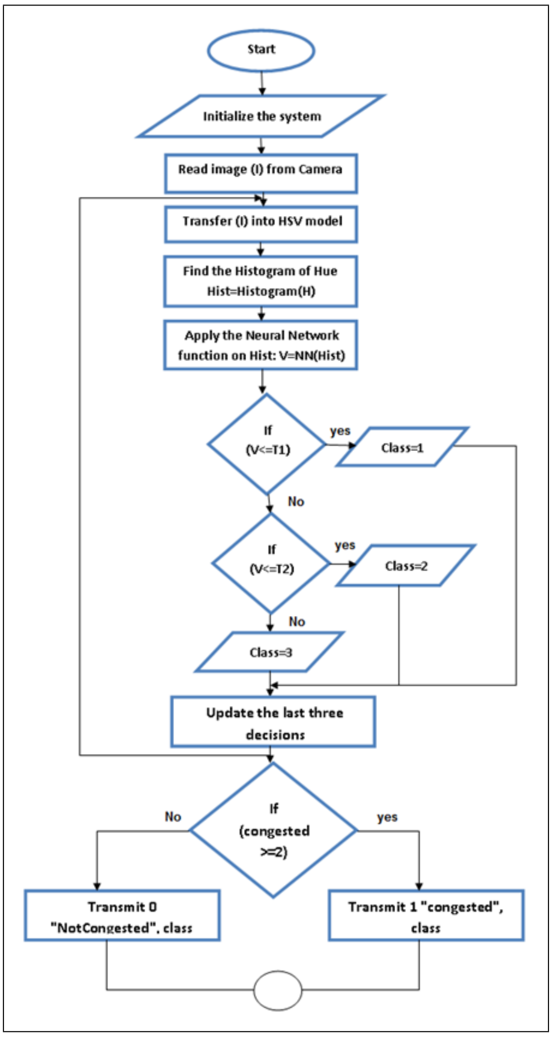



Figure 4.3: Decision making flowchart.

3. Display information: This stage used to operate the second Raspberry Pi to display the results. It programmed using python language. We assume that when the image classified to class "1",then the percentage of congestion is less than "10%". And if it classified to class "2", the percentage of congestion is less than "60%". Otherwise it is greater

than "60%". figure 4.4 flowchart for display information

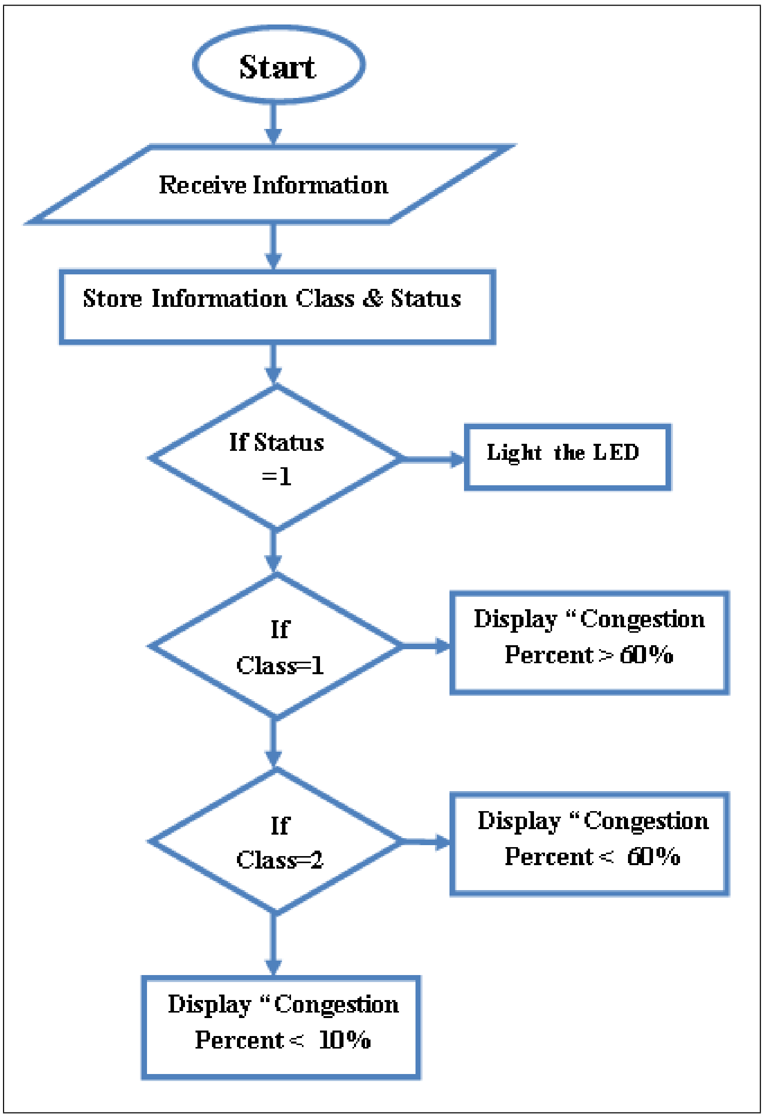



Figure 4.4: Flowchart for display information.

### 4.1.2 Software Programming Language

Firstly, we use Matlab code to create neural network, which gives the parameters that can be used as constant values to the function. We use two raspberry pi boards, which support a lot of programming languages. with the first raspberry pi we use octave which is a high- level interrupted language, quite similar to Matlab so that our programs are easily portable. The data is transmitted between the two Pi's using python network programming, and in second raspberry pi we use the octave and python programs to compare the data and to show it on the LCD screen and the light sign.

### 4.1.3 Hardware Implementation

#### 4.1.3.1 Logitech Camera Implementation

First, we install the fswebcam backage by type *sudo apt-get install fswebcam*on the terminal. then enter the command fswebcam followed by a filename and a picture will be taken using the webcam, and save to the filename [21]. we use the camera to take picture to the road of ain sara street and saved them on the folder name "RoadImages" then we use this folder continuously to take picture from it and convert them to HSV modle and the last step take the histogram from the hue picture and pass it to the function.


Figure 4.5: Raspberry pi with Logitech camera.

#### 4.1.3.2 Wi-Fi Implementation

We use socket programming to transfer data between two Pi's. A socket is an end point of communication between two systems on a network. To be precise, a socket is a combination of IP address and port on one system. So on each system a socket exists for a process interacting with the socket on other system over the network. A combination of local socket and the socket at the remote system is also known a 'Four tuple' or '4-tuple'. Each connection between two processes running at different systems can be uniquely identified through their 4-tuple [22]. The Raspberry that is doing the image processing will be the server to transmit the data as sockets, and the Raspberry on the other side will be a client and receive the data. Figure 4.6 shows the connection between client and server.

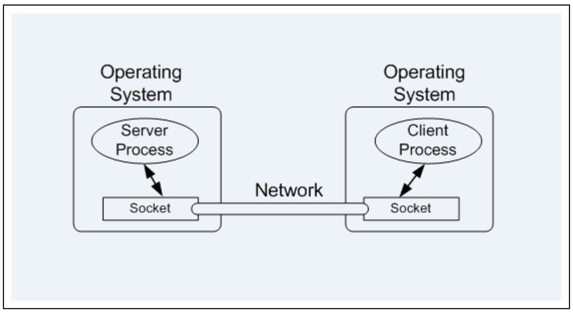



Figure 4.6: connection between client and server via socket programming [22].

#### 4.1.3.3 LED Implementation

We use red LED to display the result that comes from the first raspberry pi via Wireless to the second raspberry pi. These result depend on the last three decision, if the number of photo show a congestion is grater than tow then the led turn on, otherwise the led turn off. Figure 4.8 represent the blinking led using python program on the raspberry pi.

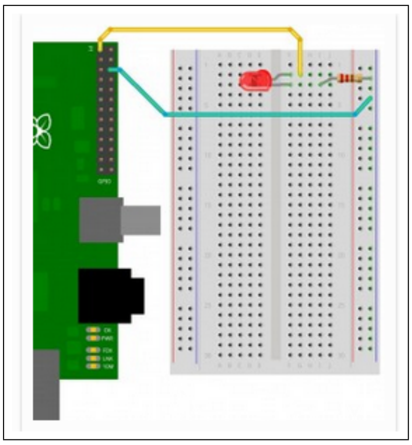


Figure 4.7: Connecting Raspberry pi with LED diagram [23].

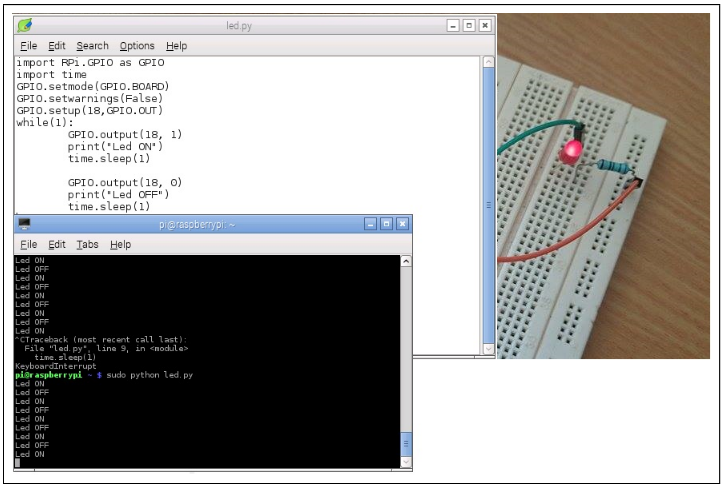



Figure 4.8: Test LED Blinking with Raspberry Pi.

#### 4.1.3.4 LCD Screen Implementation

We use python language to connect 16X2 LCD with raspberry pi, to display on it the percentage of congestion. Figure 4.9 represent the connecting raspberry pi with LCD diagram.

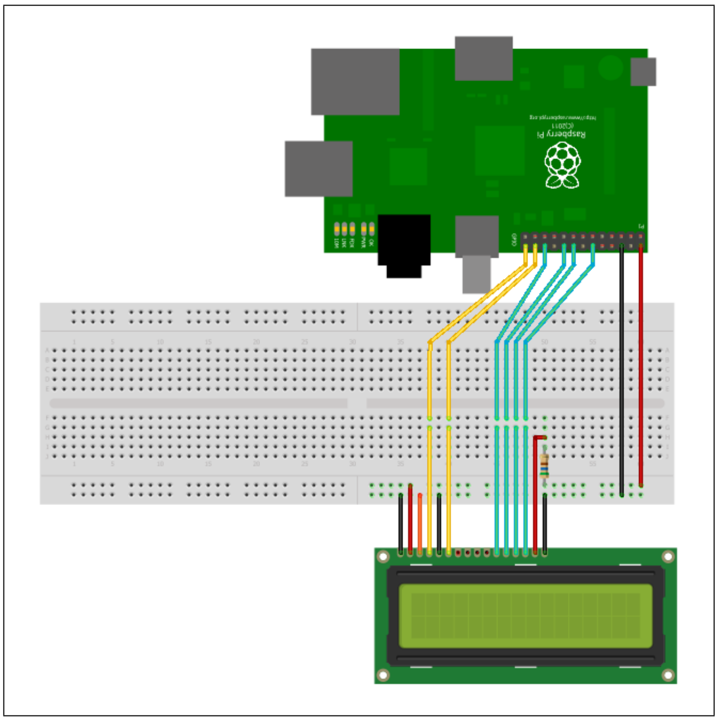


Figure 4.9: Connecting raspberry pi with LCD diagram [24].

# Chapter 5

# Validation and Discussion

## 5.1 Feature Extraction Analysis

### 5.1.1 HSV Model

We chose HSV model after doing several experiments of comparing between three colors model in order to get rid of the problems caused by lighting during a day. Then we give up the value and saturation to get more accurate as shown in figure (3.4). Figure 5.1 shows the image processing phases:

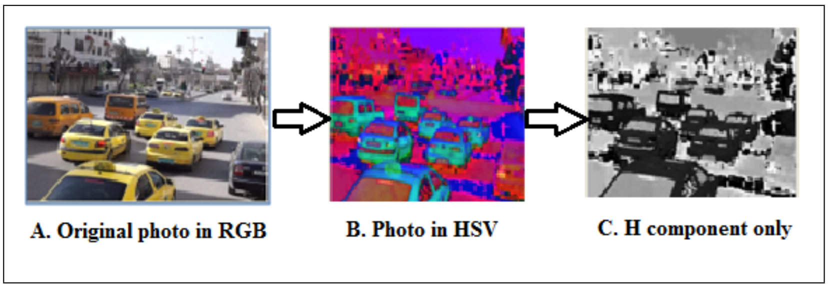



Figure 5.1: Image Processing Phases.

### 5.1.2 Number Of Bins In a Histogram

After doing several experiments, we found that the use of twenty-bin for Histogram is the best case according to the minimum number of calculations along with accurate result. Figure 5.2 show the comparisons between the results of many image at different number of bin histogram.

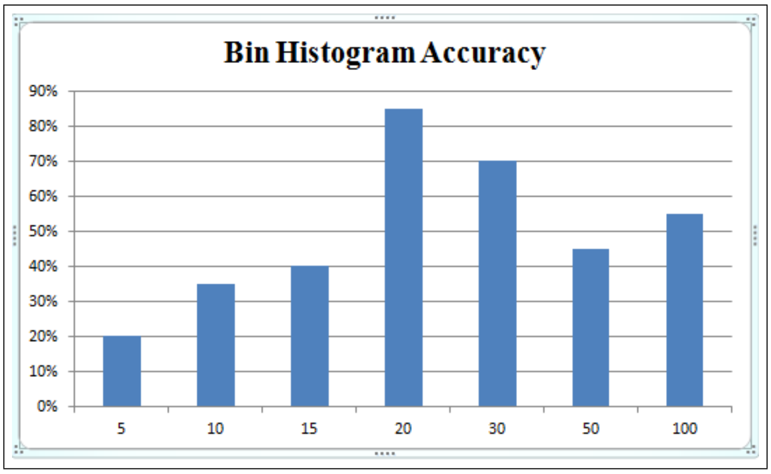



Figure 5.2: Bin Histogram Accuracy.

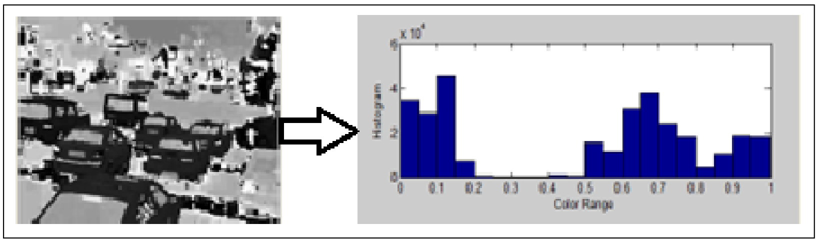



Figure 5.3: H Component To Histogram.

### 5.1.3 Number Of Neurons In The Neural Network

Choosing the best number of neurons can be done by practical tests, and after some trials we found that the use of four neurons neural network is the best for our case. Figure 5.4 shows the comparisons between the different number of neurons neural network.

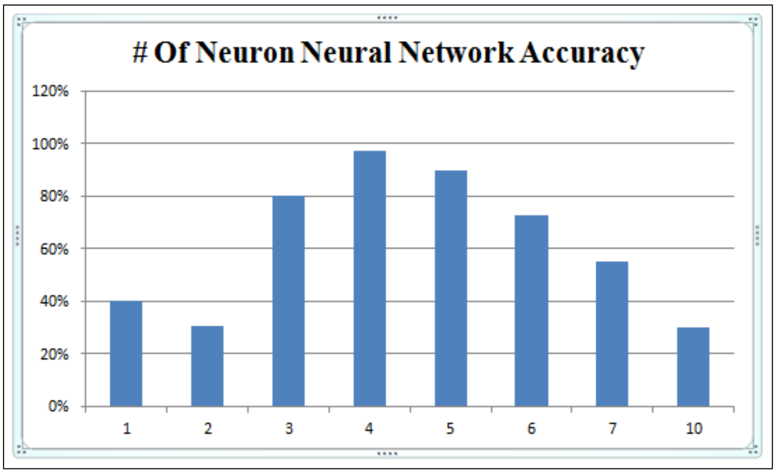



Figure 5.4: Number Of Neurons Neural Network Accuracy.

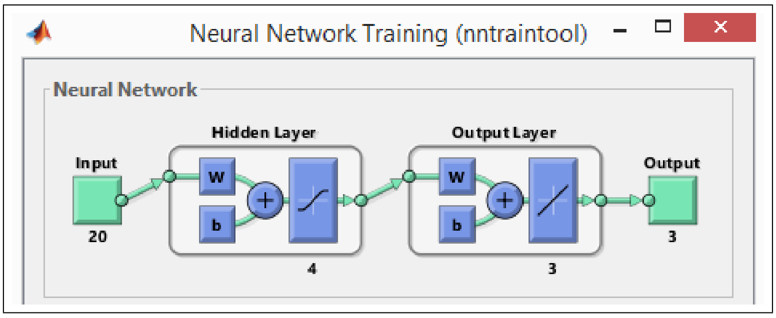



Figure 5.5: Neural Network Training.

## 5.2 Results

We have implemented a system that depends mainly on machine learning technique, Neural Networks, to detect the congestion in the street. It use camera to take snapshots for the street, Raspberry Pi microcontroller to perform required processing and display the results on LCD and LED to warn the drivers if there is congestion.

Figure 5.6 5.7 shows the result after applying the histogram of the input image on the neural network regression formula mentioned previously in section 4.1.1.

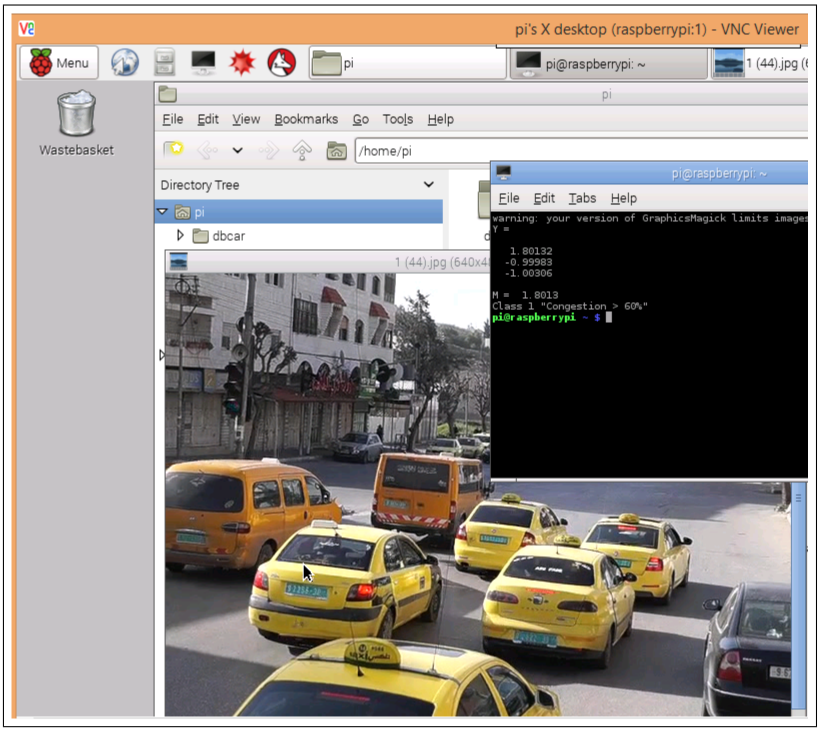



Figure 5.6: Congested Case.

## 5.3 Challenges

1. Select the best features for neural network training, there is a lot of choices and the only way to find the best one is trying.

2. Raspberry Pi programming, many tools has been tried such as Open CV, until the Octave worked very will.

3. LCD has been fault down.

## 5.4 Future work

1. Build an integrated system that form a network, where every intersection receive the street condition from near intersections.

2. Use better images to increase the system reliability.

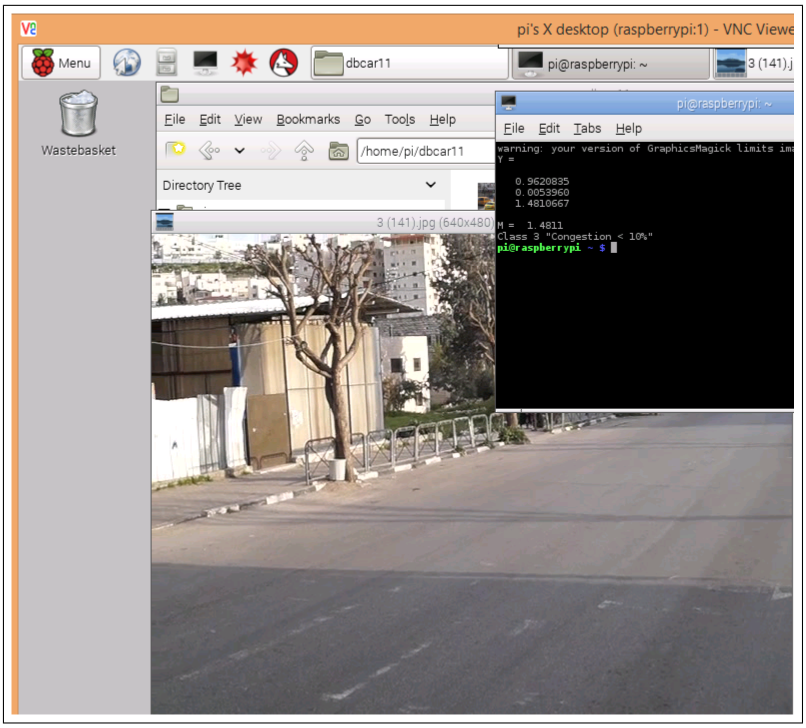



Figure 5.7: uncongested Case.

## Conclusion

The main purpose of this project is to build an embedded system to guide the drivers into less congested road when they reaches an intersection with congested direct way. In our project we studied the problem of traffic congestion in the Ain Sarah Street and we found that the image processing technique has potential to manage and solve this problem. If the congestion occurs, the system will guide the drivers to other paths via an optimal sign and show them the congestion rate. We expect this system to detect the congestion correctly and in real time.