Vehicle Speed Classifying System Based On Microcontroller

Naw April Tow
University of Computer Studies, Yangon
apriltow@gmail.com

Abstract

In real world, there are many systems or classification such as smell, light, temperature, speed. This paper presents vehicle speed classification and PIC microcontroller is used to classify as very high speed and high speed. This system can help for traffic policemen instead of watching and catching the high speed vehicle driving. This system can be viewed as four major portions; accepting the input signals, measuring the vehicle speed by using PIC16F84a, classifying vehicle speed and operating automatic alarm system for high speed vehicle. This system can also classify vehicle type by vehicle length categories. BasicPro is used to implement in microcontroller.

Key words: Vehicle speed classify, IR sensors, Vehicle length based vehicle type classify, Microcontroller PIC16F84A

1. Introduction

Traffic data collected on highways have many applications, depending in the various agencies' needs. The trapper is placed the side of roadway where impaired traffic and specific speed limited traffic. Based on recent advances in computer vision, image analysis techniques have also been applied to develop vehicle classification systems [1-4]. Under adverse real-world conditions, techniques based on image analysis are often affected by weather conditions such as trainband fog, low resolution/contrast and this often leads to low classification accuracy. There are a number of other sensing technologies relevant to vehicle classification. These technologies include infrared, Ultrasonic, radar microwave, and video detectors. There have much kind of sensors such as Infrared sensors, magnetic sensors, acoustic sensors, piezoelectric sensor, pneumatic tube, weight-in-motion (WIM), inductive loop sensor. Ultrasonic sensor and acoustic sensors are not capable of vehicle classification. They are more expensive than inductive loop sensors, especially when sufficient numbers of sensors are installed for speed estimation. Infrared sensors are expensive and sensitive to weather. Multi-channel and multi-zone passive infrared sensors measure speed and vehicle length as well as the more conventional volume and lane occupancy. The main disadvantage of infrared sensors is sensitivity to weather conditions, including fog, rain, or snow [5]. They have their own strengths and weaknesses. Vehicle classification is types of pattern recognition, so many effective pattern recognition methods and combinations of multiple sensors have been used for classification and identification of vehicles in a particular vehicle classification system which has achieved satisfactory results. Vehicle-length-based classifiers use vehicle length to group vehicles into classes. A single sensor or combination of different types of length sensors are normally used, including loops, piezoelectric and electrical contact closures. Vehicle speed can be derived from time differences between two sensors [6][7].

2. System Overview

In this paper, microcontroller based vehicle speed classification approach is developed by modeling Small Vehicle Speed Classifying (SVSC) system. Vehicle speed type classification system uses PIC 16F84A. Vehicle must cross between start sensor A and stop sensor B. Each sensor includes IR transmitters and IR receivers as shown in Figure 1. Figure 2 shows sensor A and B as inputs to PIC 16F84A and, length and height sensors are also for inputs. And PIC calculates speed using sensor A and B, and vehicle type using length and height sensors. And results display on LCD. If vehicle speed is high or very high, then automatic alarm is active with buzzer. The resulting recognition speeds are very high speed, high speed, and normal speed. Speed range for normal speed is between 5 and 30miles/hour (greater than or equal 2000 milliseconds), for high speed between 30miles/hour and 60miles/hour (between 500 and 2000 milliseconds), and for very high speed over 60 miles/hour (less than or equal 500 milliseconds).

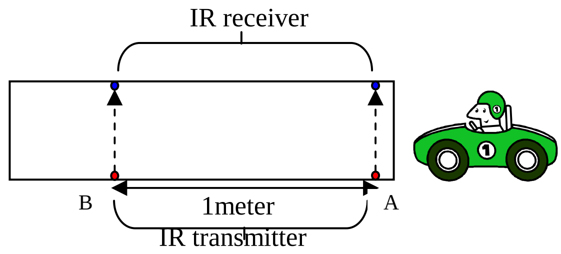

Figure 1: Sample design of this system

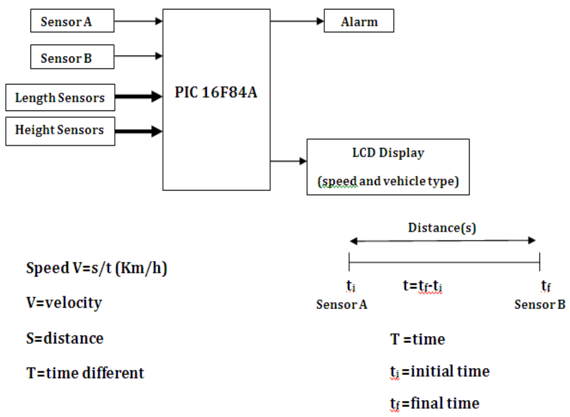

Figure 2: **Block diagram of this system**

2.1. PIC Microcontroller

A microcontroller is a computer control system on a single chip. It has many electronic circuits built into it, which can decode written instructions and convert them to electrical signals. The microcontroller will then step through these instructions and execute them one by one. As an example of this a microcontroller could be instructed to measure the temperature of a room and turn on a heater if it goes cold. Microcontrollers are now changing electronic designs. Instead of hard wiring a number of logic gates together to perform some function we now use instructions to wire the gates electronically. The list of these instructions given to the microcontroller is called a program [8].

Microcontrollers include EPROM program memory, user RAM for storing program data, timer circuits, an instruction set, special function registers, power on reset, interrupts, low power consumption and a security bit for software protection. Some microcontrollers like the 16F818/9 devices include on board A to D converters. In the 16F84 microcontroller there are 4 oscillator options. An RC (Resistor/Capacitor) oscillator which provides a low cost solution. An LP oscillator, i.e. 32kHz crystal, which minimises power consumption. XT which uses a standard crystal configuration. HS is the high-speed oscillator option. Common crystal frequencies would be 32 kHz, 1 MHz, 4 MHz, 10 MHz and 20 MHz. The input components would consist of digital devices such as, switches, push buttons, pressure mats, float switches, keypads, radio receivers etc. and analogue sensors such as light dependant resistors, thermistors, gas sensors, pressure sensors, etc. The control unit is of course the microcontroller. The microcontroller will monitor the inputs and as a result the program would turn outputs on and off. The microcontroller stores the program in its memory, and executes the instructions under the control of the clock circuit. The output devices would be made up from LEDs, buzzers, motors, alpha numeric displays, radio transmitters, 7 segment displays, heaters, fans etc [9].

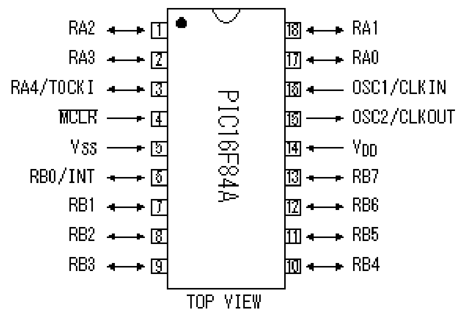

Figure 3: Pin Diagram of PIC16F84A

3. Hardware Implementation

3.1. IR sensor

This system only use IR sensor for input signals. If vehicle across between IR transmitter and receiver then signal output is 1. If vehicle doesn't across between IR transmitter and receiver, then signal output is 0. As shown in Figure 4. Three pairs of IR sensors are used for length sensor and another three pairs of IR sensors are used for height sensor. Two pairs of IR sensors are used for sensor A and sensor B.

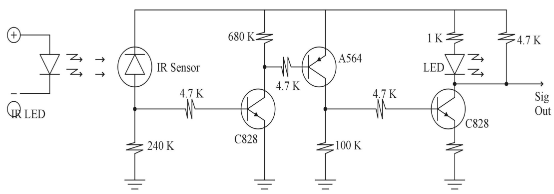

Figure 4: IR Sensor Circuit design

3.2. Circuit explanation of this system

Figure 5 shows vehicle speed classification system is used to classify speed with two input sensor in PIC16F84A. This system also classifies vehicle type by length with three length sensors and height with three height sensors. In PIC16F84A microcontroller; RA0 is input for push button and output for alarm buzzer, RA1 and RA2 are input for vehicle length, RA3 and RA4 are input for vehicle height, RB0 is input for start sensor, and RB1 is input for stop sensor. RB2 to RB7 are output for LCD display. In this system, 4MHz crystal is used. Distance between start point and stop point is one meter. Figure 6 shows two line, LCD display. In LCD pin connection with PIC; PIC port RB2 is connected to LCD's enable line 'E', RA3 is connected to RS, RB4 is connected to D4, RB5 is connected to D5, RB6 is connected to D6, and RB7 is connected to D7 as shown in Figure 5.

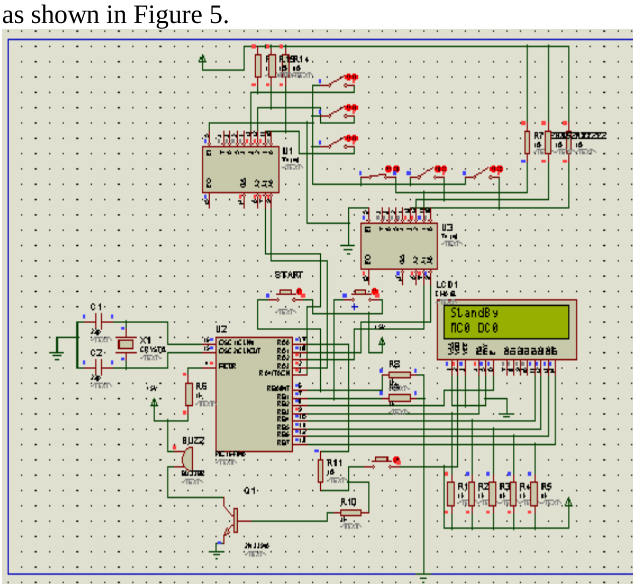

Figure 5: Schematic diagram of this system

4. Software Implementation

In this paper, system implements with PIC 16F84A to measure vehicle speed on roadway and classifies type of vehicle and then memory can store data such as vehicle speed and types of vehicle. This system can simulate with Proteus 7 Professional version. Proteus 7 Professional is circuitry software that helps user to simulate schematic circuits.

4.1. SVSC System

SVSC System consists of three main parts. These are sensing with sensors, processing with PIC and displaying on LCD. System flow of SVSC System is shown in following figure. In initialization, LCD is driven by PORTB (bit-2 to bit-7) of microcontroller. Bit-0 and bit-1 of PORTB are used as start sensor and stop sensor. At the beginning of the system, LCD displays as “Stand_By". If “start” sensor is pressed, then initial time will measure as count (millisecond) and display on LCD. If “stop” sensor is pressed, then PIC will compare with three conditions for speed measurement. If stop sensor is not pressed, then count will increase as shown in figure 7. LCD displays speed type. At the same time, bit-1 and bit-2 of PORTA are used for length sensors; bit-3 and bit-4 of PORTA are used for height sensors for sensor configuration. If speeds are high or very high speed, then alarm is out with buzzer and then microcontroller can store these speeds. When “recall” button is pressed, LCD displays these stored data. Bit-0 of PORTA is used for “recall” button and alarm.

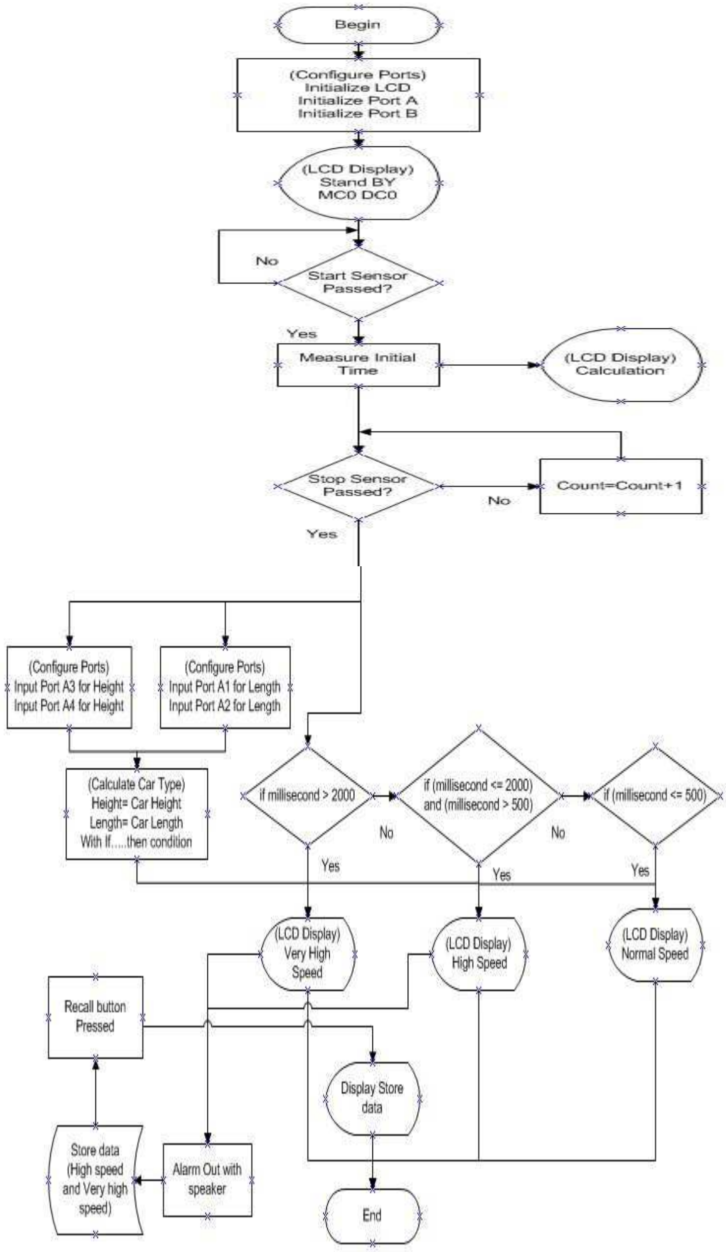

Figure 7: Flow chart of this system

4.2. Procedure of high speed trap

Implementation procedure includes as follow:

1. Accept signal from start point

2. Display on LCD “Stand_By” and “MC0” (memory display counter), “DC0” (display mode counter)
3. Calculate count for speed
4. Accept signal from stop point
5. Don't store in memory if it is normal speed. Store memory if it is high speed or very high speed.
6. Display on LCD, for memory store as memory no (“Mem?#”), for speed (“???ms”), for speed class(high speed “HS” or very high speed “VHS”), for vehicle type (length “L=?”, height “H=?”). Nine data can be stored on memory (from “Mem0#” to “Mem8#”.
7. Press push button until “Mem8#”in order to recall the stored data.

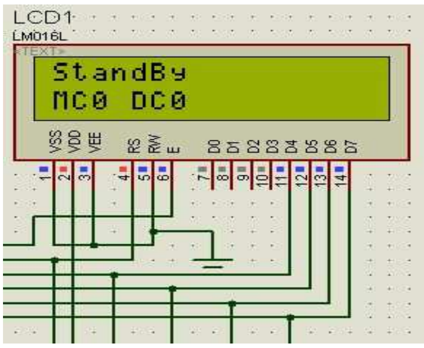

Figure 6: Schematic diagram of LCD display

4.2. Calculation vehicle speed

In this calculation, S is distance (one meter between start point and stop point). T is different time with millisecond (from start count at start point to stop count at stop point). V is speed.

V=S/T

S=1 meter

$T=t_f-t_i$

T= different time

t_f =terminal time

t_i = initial time

$$1\ \text{kph} = \frac{1\ \text{km}}{1\ \text{hour}}\ \frac{1000\ \text{m}}{1\ \text{km}}\ \frac{1\ \text{hour}}{3600\ \text{s}} = 0.2777\ldots\ \text{m/s} \sim \tfrac{1}{4}\ \text{m/s}$$

$$1\ \text{mph} = \frac{1\ \text{mile}}{1\ \text{hour}}\ \frac{1609\ \text{m}}{1\ \text{mile}}\ \frac{1\ \text{hour}}{3600\ \text{s}} = 0.4469\ldots\ \text{m/s} \sim \tfrac{1}{2}\ \text{m/s}$$

[10]

Table 1 shows many vehicle speed type. Results are calculated with speed formula. Table 2 shows vehicle speed type and speed class results are calculated with PIC and display on LCD.

Table 1: Sample of speed vehicle speed

mph	km/h	m/s	ms
150	241.5	66.8955	14.95
121	194.81	53.9624	18.5
60	96.6	26.7582	37.3
48	77.28	21.4066	46.7
30	48.3	13.3791	74.7
5	8.05	2.22985	448.4

Table 2: Sample of vehicle speed

Memory store No	Vehicle speed (PIC)	Speed Class	Vehicle Types (from length sensors and height sensors)	
			Length, Height	Type
Mem0#	450ms	VHS	L=1, H=1	Small
Mem1#	409ms	VHS	L=2, H=1	Normal
Mem2#	368ms	VHS	L=3, H=2	Medium
Mem3#	1063ms	HS	L=4, H=2	Big
Mem4#	941ms	HS	L=1, H=3	Small
Mem5#	777ms	HS	L=2, H=3	Normal
Mem6#	1025ms	HS	L=3, H=4	Medium
Mem7#	532ms	HS	L=4, H=4	Big
Mem8#	940ms	HS	L=1, H=1	Small

Figure 8 shows mechanical structure of this system. Eight IR transmitters and receivers are used in this system. Two sensors are start and stop. Three sensors are length on horizontal and three sensors are height on vertical. Figure 9 shows LCD display is used for display vehicle speed and type results. Microcontroller PIC 16F84A is used for calculation and classification.

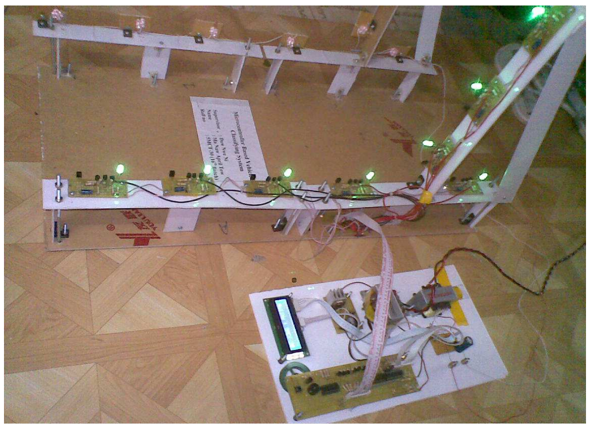

Figure 8: Mechanical structure of Vehicle speed and type classification System

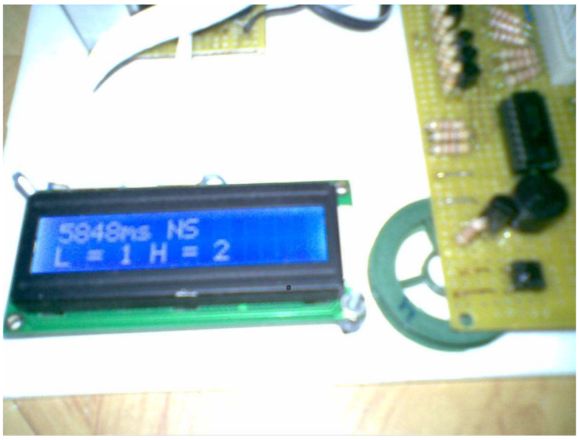

Figure 9: Mechanical structure of LCD display of this system

5. Limitations

Vehicle type can be classified with only three inputs data such as height, length, and different time. This system can not know Vehicle's width. LCD display can only show the type of car in length and height and this system can only define the type of car: small type (Length = 1 and Height ≥ 1), normal type (Length = 2 and Height ≥1), medium type (Length =3 and Height ≥ 1), and big type (Length =4 and Height ≥ 1) because this system is small model for vehicle speed classifying system.

6. Conclusion

In this paper, system can only classify four vehicle types and measure vehicle speed. This system can help for traffic policemen who watch and catch impaired vehicle driving with high speed on the road. This system receives good results by implementing in PIC16F84A. Support Vector Machines (SVMs) can be used for vehicle type classification. And this system can expend to classify vehicle type with video images.

10. References

[1] Ha, D.M.; Lee, J.-M; Kim, Y.-D, "Neural-edged-based vehicle detection and traffic parameter extraction.", 2004.
[2] Stefano Messelodi, S.; Modena, C.M.; Cattoni, G, "Vision-based bicycle/motorcycle classification", 2007.
[3] Klausner, A.; Tengg, A.; Rinner, B, "Vehicle Classification on Multi-Sensor Smart Cameras Using Feature- and Decision-Fusion", 2007.
[4] Gupe, S.; Masoud, O.; Papanikolopoulos, P, "Vision-based vehicle classification", 2000.
[5] Mimbela, L. Y. and Lawrence A. Klein "Summary of Vehicle Detection and Surveillance Technologies Used in Intelligent Transportation Systems." Report, 2000.
[6] Wenbin Zhang, Qi Wang and Chunguang Suo "A novel Vehicle Classification Using Embedded Strain Gauge Sensors", 2008.
[7] John Heidemann Fabio Silva, Xi Wang "Sensors for Unplanned Roadway Events--Simulation and Evaluation", Draft Final Report.
[8]Datasheet of the PIC16F84A.
[9] Dave Smith, "PIC in Practice", a project based approach.
[10]"Speed and Velocity",The Physic Hypertextbook_files
[11]Hongwei Wu and Jerry M. Mendel "Classification of Ground Vehicles From Acoustic Data Using Fuzzy Logic Rule-Based Classifiers: Early Results"
[12] Sun, Carlos "An Investigation in the Use of Inductive Loop Signatures for Vehicle Classification", 1999.
[13] Transportation Research Board "Expanding Metropolitan Highways", 1995.
[14] Ritchie, Stephen G., Seri Park, Cheol Oh and Carlos Sun, "Field Investigation of Advanced Vehicle Re-identification Techniques and Detector Technologies-Phase1.", 2002.