

An Intelligent Automatic Traffic Light Controller using Embedded Systems

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ABSTRACT: Nowadays people were struggling to travel from one place to another in today's city traffic. Since our project is based on the density of the vehicles, traffic signals and its timing were controlled. When the density of the vehicles are low then it is analysed by using IR sensors, then according to that the signal timings will be changed. And also, vehicles which break the traffic rules during stop signal (Red signal) is observed by using OCR (Optical Character Recognition) and warning is given to the person through message alert if it is the first time. If the same vehicle is captured and analysed for the second time then it is made as a complaint and forwarded to the nearby police control room. Thus our project is mainly implemented to save waiting time unnecessarily in traffic signals.

KEYWORDS: IR (infrared) sensor, Image processing, Micro-controller, Digital Display.

I. INTRODUCTION

Traffic research has the goal to optimize traffic flow of people and goods. As the number of road users constantly increases, and resources provided by current infrastructures are limited, intelligent control of traffic will become a very important issue in the future. However, some limitations to the usage of intelligent traffic control exist. Avoiding traffic jams for example is thought to be beneficial to both environment and economy, but improved traffic-flow may also lead to an increase in demand. There are several models for traffic simulation. In our research we focus on optimization of traffic light controller in a city using IR sensor and monitoring using controller 16F877A. Traffic light optimization is a complex problem. Even for single junctions there might be no obvious optimal solution. With multiple junctions, the problem becomes even more complex, as the state of one light influences the flow of traffic towards many other lights. Another complication is the fact that flow of traffic constantly changes, depending on the time of day, the day of the week, and the time of year. Roadwork and accidents further influence complexity and performance. In this paper, we propose two approaches, the first approach- to calculate the density of the vehicles/controller and according to that signal timings will be changed, second approach- to take data/input/image from object/ subject/vehicle and in to process the input data by Computer and Microcontroller and finally display it on the traffic light signal to control the System.

The problems of typical conventional traffic light Controller are mentioned below:

A. Heavy Traffic Jam with increasing number of vehicles on road

Heavy traffic congestion has substantially increased in major cities. This happened usually at the main junctions commonly in the morning, before office hour and in the evening, after office hours. The main effect of this matter is increased time wasting of the people on the road. The solution for this problem is by developing the program which

different setting delays for different junctions. The delay for junctions that have high volume of traffic should be setting longer than the delay for the junction that has low of traffic. This operation is calling Normal Model.

B. No traffic, but still need to wait

At certain junctions, sometimes even if there is no traffic, people have to wait. Because the traffic light remains red for the preset time period, the road users should wait until the light turn to green. If they run the red light, they have to pay fine. The solution of this problem is by developing a system which detects traffic flow on each road and set timings

C. Rules followed, to avoid accidents

In traffic signal, vehicles which breaks the traffic rules like crossing the red signal is captured by a camera and the number plate is recognized by using OCR and the vehicle owners mobile number is taken and a warning message is given. If suppose the same vehicle is captured and recognized next time then the system will analyse the number plate of the vehicle and that is given to the near by police control room

The main objective for this project is to design a

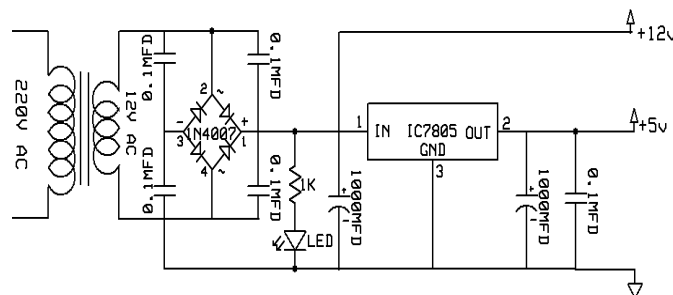
Program and implement hardware of intelligent traffic light system suitable for real life implementations. This project also aims to design a safe and efficient traffic flow, to assign the right way and minimizes the delay or waiting time at road. The traffic jam will be reduced by increasing the green signal time on busy road and decrease the red signal time in non busy road. The information about congestion on road or possible alternate routes can also be informed to car drivers on demand on his/her GSM mobile phone. Infra Red –Light Emitting Diode (IRLED) transmitter and receivers are used to measure the traffic flow. In short, this project is a real-time, GSM enabled and intelligent Traffic Light Controller.

This paper is organized as follows: In section II a brief study of traffic controllers designs and the circuits. The proposed model of ITLC is presented in section III. Design, hardware and software details are explained in this section. Section IV deals with performance evaluation of the proposed system with the conventional fixed time traffic light controllers. Various Performance measures are discussed in this section. Finally, the paper is concluded in section V, which presents conclusion, commercialization of project and future scope for the proposed system.

II. DESIGN AND DEVELOPMENT OF THE SYSTEM

POWER SUPPLY CIRCUIT

Development of the complete intelligent traffic light control and monitoring system includes lots of study and implementation work. The implementation work of the complete data logger is divided into points discussed below. Power Supply: As per the power requirement of the hardware of the intelligent traffic light control and monitoring system, supply of +5V w.r.t GND is developed and it is shown in below fig2.

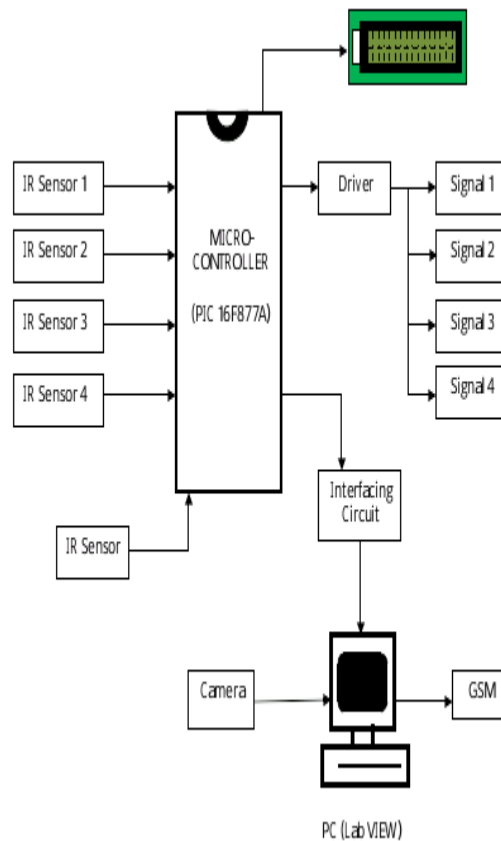


The complete circuitry is operated with TTL logic level of 0-5V. It comprise of 0V to 9V transformer to step down the 220V AC supply to 9V AC. Further a bridge rectifier converts the 9V into $9\sqrt{2}$ DC. It is further filtered through a 1000µF capacitor and then regulated using 7805 to get +5V. To isolate the output voltage of +5V from noise further filtering 220µF capacitor is done.

III. BLOCK DIAGRAM

Given below is the block diagram of the project. We are using a programmable IC(PIC16F877A),with a RAM memory 368bytes and ROM 8K which is of Flash type, to control the operations. And in tis projectwe propose two approaches for the intelligent traffic light controller system, the first approach- to calculate the density of the vehicles is sensed by using a IRsensor and it is placed on both sides of the road sides and the density is calculated and executed by using controller and according to that signal timings will be changed, Second approach- to take to analyse the vehicle which breaks the traffic rules and the image is captured by using a web camera and by using OCR(Optical Character Recognition) and in to process the input data by Computer and Microcontroller and its al done by using the labview and the complaint is forwarded to the near by police control number. And the block diagram is given below in fig1.

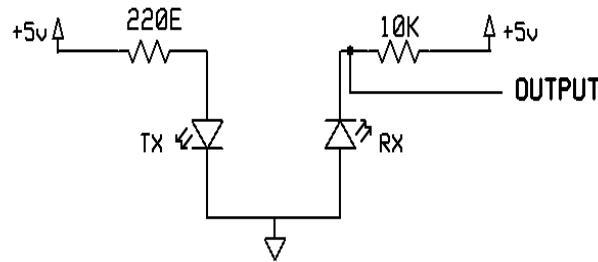
BLOCK DIAGRAM FORINTELLIGENT TRAFFIC LIGHTCONTROLLER



IR SENSOR:

Infrared radiation (IR) is electromagnetic radiation with a wavelength between 0.7 and 300 micrometers, which equates to a frequency range between approximately 1 and 430 THz.

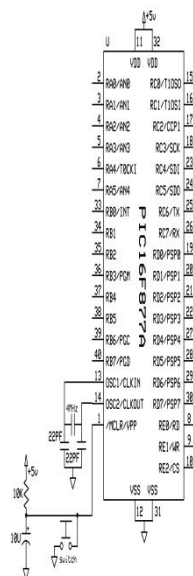
Its wavelength is longer (and the frequency lower) than that of visible light, but the wavelength is shorter (and the frequency higher) than that of terahertz radiation/microwaves. Bright sunlight provides an irradiance of about 1 kilowatt per square meter at sea level. Of this energy, 527 watts is infrared light, 445 watts is visible light, and 32 watts is ultraviolet light.



Infrared imaging is used extensively for military and civilian purposes. Military applications include target acquisition, surveillance, nightvision, homing and tracking. Non-military uses include thermal efficiency analysis, remote temperature sensing, short-ranged wireless communication, spectroscopy, and weather forecasting. Infrared astronomy uses sensor-equipped telescopes to penetrate dusty regions of space, such as molecular clouds; detect cool objects such as planets, and to view highly red-shifted objects from the early days of the universe.

PIC MICROCONTROLLER

PIC (16F877A) is a family of Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1640. Originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to "Programmable Interface Controller. PICs are popular with both industrial developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability.



Core architecture

The PIC architecture is characterized by the following features:

- Separate code and data spaces (Harvard architecture) for devices other than PIC32, which has a Von Neumann architecture.

- A small number of fixed length instructions
- Most instructions are single cycle execution (2 clock cycles), with one delay cycle on branches and skips
- One accumulator (W0), the use of which (as source operand) is implied (i.e. is not encoded in the opcode)
- All RAM locations function as registers as both source and/or destination of math and other functions.
- A hardware stack for storing return addresses
- A fairly small amount of addressable data space (typically 256 bytes), extended through banking
- Data space mapped CPU, port, and peripheral registers

There is no distinction between memory space and register space because the RAM serves the job of both memory and registers, and the RAM is usually just referred to as the register file or simply as the registers.

Data space (RAM)

PICs have a set of registers that function as general purpose RAM. Special purpose control registers for on-chip hardware resources are also mapped into the data space. The addressability of memory varies depending on device series, and all PIC devices have some banking mechanism to extend addressing to additional memory. Later series of devices feature move instructions which can cover the whole addressable space, independent of the selected bank. In earlier devices, any register move had to be achieved via the accumulator.

To implement indirect addressing, a "file select register" (FSR) and "indirect register" (INDF) are used. A register number is written to the FSR, after which reads from or writes to INDF will actually be to or from the register pointed to by FSR. Later devices extended this concept with post- and pre- increment/decrement for greater efficiency in accessing sequentially stored data. This also allows FSR to be treated almost like a stack pointer (SP). External data memory is not directly addressable except in some high pin count PIC18 devices.

Code space

The code space is generally implemented as ROM, EPROM or flash ROM. In general, external code memory is not directly addressable due to the lack of an external memory interface. The exceptions are PIC17 and select high pin count PIC18 devices.

Word size

The word size of PICs can be a source of confusion. All PICs handle (and address) data in 8-bit chunks, so they should be called 8-bit microcontrollers. However, the unit of addressability of the code space is not generally the same as the data space. For example, PICs in the baseline and mid-range families have program memory addressable in the same word size as the instruction width, i.e. 12 or 14 bits respectively. In contrast, in the PIC18 series, the program memory is addressed in 8-bit increments (bytes), which differs from the instruction width of 16 bits.

In order to be clear, the program memory capacity is usually stated in number of (single word) instructions, rather than in bytes.

Stacks

PICs have a hardware call stack, which is used to save return addresses. The hardware stack is not software accessible on earlier devices, but this changed with the 18 series devices.

Hardware support for a general purpose parameter stack was lacking in early series, but this greatly improved in the 18 series, making the 18 series architecture more friendly to high level language compilers.

Instruction set

A PIC's instructions vary from about 35 instructions for the low-end PICs to over 80 instructions for the high-end PICs. The instruction set includes instructions to perform a variety of operations on registers directly, the accumulator and a literal constant or the accumulator and a register, as well as for conditional execution, and program branching.

Some operations, such as bit setting and testing, can be performed on any numbered register, but bi-operand arithmetic operations always involve W (the accumulator) ; writing the result back to either W or the other operand register. To load a constant, it is necessary to load it into W before it can be moved into another register. On the older cores, all register moves needed to pass through W, but this changed on the "high end" cores.

PIC cores have skip instructions which are used for conditional execution and branching. The skip instructions are: 'skip if bit set', and, 'skip if bit not set'. Because cores before PIC18 had only unconditional branch instructions, conditional jumps are implemented by a conditional skip (with the opposite condition) followed by an unconditional branch. Skips are also of utility for conditional execution of any immediate single following instruction.

The PIC architecture has no (or very meager) hardware support for automatically saving processor state when servicing interrupts. The 18 series improved this situation by implementing shadow registers which save several important registers during an interrupt.

In general, PIC instructions fall into 5 classes:

1. Operation on W with 8-bit immediate ("literal") operand. E.g. movlw (move literal to W), andlw (AND literal with W). One instruction peculiar to the PIC is retlw, load immediate into W and return, which is used with computed branches to produce lookup tables.
2. Operation with W and indexed register. The result can be written to either the W register (e.g. addwf reg,w), or the selected register (e.g. addwf reg,f).
3. Bit operations. These take a register number and a bit number, and perform one of 4 actions: set or clear a bit, and test and skip on set/clear. The latter are used to perform conditional branches. The usual ALU status flags are available in a numbered register so operations such as "branch on carry clear" are possible.
4. Control transfers. Other than the skip instructions previously mentioned, there are only two: goto and call.
5. A few miscellaneous zero-operand instructions, such as return from subroutine, and sleep to enter low-power mode.

Performance

The architectural decisions are directed at the maximization of speed-to-cost ratio. The PIC architecture was among the first scalar CPU designs and is still among the simplest and cheapest. The Harvard architecture in which instructions and data come from separate sources simplifies timing and microcircuit design greatly, and this benefits clock speed, price, and power consumption.

The PIC instruction set is suited to implementation of fast lookup tables in the program space. Such lookups take one instruction and two instruction cycles. Many functions can be modelled in this way. Optimization is facilitated by the relatively large program space of the PIC (e.g. 4096 x 14-bit words on the 16F690) and by the design of the instruction set, which allows for embedded constants. For example, a branch instruction's target may be indexed by W, and execute a "RETLW" which does as it is named - return with literal in W.

Execution time can be accurately estimated by multiplying the number of instructions by two cycles; this simplifies design of real-time code. Similarly, interrupt latency is constant at three instruction cycles. External interrupts have to be synchronized with the four clock instruction cycle, otherwise there can be a one instruction cycle jitter. Internal interrupts are already synchronized. The constant interrupt latency allows PICs to achieve interrupt driven low jitter timing sequences. An example of this is a video sync pulse generator.

Limits

The PIC architectures have several limits:

- Only one accumulator
- A small instruction set
- Operations and registers are not orthogonal; some instructions can address RAM and/or immediate constants, while others can only use the accumulator
- Memory must be directly referenced in arithmetic and logic operations, although indirect addressing is available via 2 additional registers
- Register-bank switching is required to access the entire RAM of many devices

The following limitations have been addressed in the PIC18, but still apply to earlier cores:

- Conditional skip instructions are used instead of conditional jump instructions used by most other architectures
- Indexed addressing mode is very rudimentary
- Stack:

- The hardware call stack is so small that program structure must often be flattened
- The hardware call stack is not addressable

LCD DISPLAY

Liquid crystal cell displays (LCDs) are used in similar applications where LEDs are used. These applications are display of display of numeric and alphanumeric characters in dot matrix and segmental displays.

Working:

When sufficient voltage is applied to the electrodes the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarizer, which would result in activating/highlighting the desired characters. The power supply should be of +5v, with maximum allowable transients of 10mv. To achieve a better/suitable contrast for the display the voltage (VL) at pin 3 should be adjusted properly. A module should not be removed from a live circuit.

The ground terminal of the power supply must be isolated properly so that voltage is induced in it. The module should be isolated properly so that stray voltages are not induced, which could cause a flicking display. LCD is lightweight with only a few, millimeters thickness since the LCD consumes less power, they are compatible with low power electronic circuits, and can be powered for long durations. LCD does not generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. LCDs have long life and a wide operating temperature range. Before LCD is used for displaying proper initialization should be done.

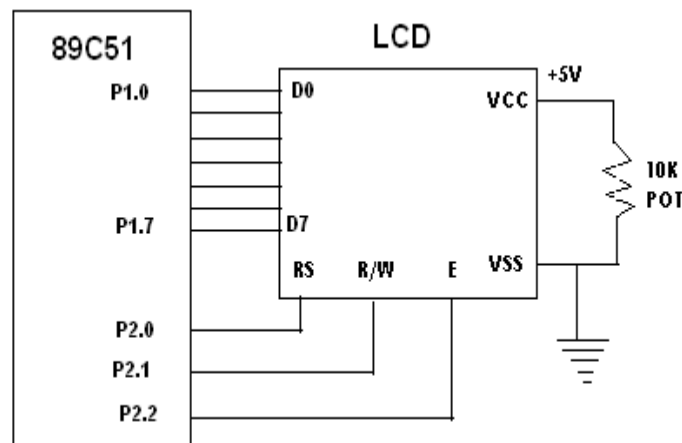
LCDs with a small number of segments, such as those used in digital watches and pocket calculators, have individual electrical contacts for each segment. An external dedicated circuit supplies an electric charge to control each segment. This display structure is unwieldy for more than a few display elements. Small monochrome displays such as those found in personal organizers, or older laptop screens have a passive-matrix structure employing super-twisted nematic (STN) or double-layer STN (DSTN) technology—the latter of which addresses a color-shifting problem with the former—and color-STN (CSTN)— wherein color is added by using an internal filter. Each row or column of the display has a single electrical circuit.

The pixels are addressed one at a time by row and column addresses. This type of display is called passive-matrix addressed because the pixel must retain its state between refreshes without the benefit of a steady electrical charge. As the number of pixels (and, correspondingly, columns and rows) increases, this type of display becomes less feasible. Very slow response times and poor contrast are typical of passive matrix addressed LCDs. High resolution color displays such as modern LCD computer monitors and televisions use an active matrix structure. A matrix of thin-film transistors (TFTs) is added to the polarizing and color filters. Each pixel has its own dedicated transistor, allowing each column line to access one pixel. When a row line is activated, all of the column lines are connected to a row of pixels and the correct voltage is driven onto all of the column lines.

The row line is then deactivated and the next row line is activated. All of the row lines are activated in sequence during a refresh operation. Active-matrix addressed displays look "brighter" and "sharper" than passive-matrix addressed displays of the same size, and generally have quicker response times, producing much better images. A general purpose alphanumeric LCD, with two lines of 16 characters. So the type of LCD used in this project is 16 characters * 2 lines with 5*7 dots with cursor, built in controller, +5v power supply, 1/16 duty cycle.



LCD INTERFACING WITH MICROCONTROLLER:



ADVANTAGES:

1. Consume much lesser energy (i.e. low power) when compared to LEDs.
2. Utilizes the light available outside and no generation of light.
3. Since very thin layer of liquid crystal is used, more suitable to act as display elements (in digital watches, pocket calculators, ect.)
4. Since reflectivity is highly sensitive to temperature, used as temperature measuring sensor.
5. Very cheap.

DISADVANTAGE:

1. Angle of viewing is very limited.
2. External light is a must for display.
3. Since not generating its own light and makes use of external light for display, contrast is poor.
4. Cannot be used under wide range of temperature.

APPLICATIONS:

1. Watches
2. Fax & Copy machines

IV. OPTICAL CHARACTER RECOGNITION

Optical character recognition, usually abbreviated to OCR, is the mechanical or electronic conversion of scanned or photographed image of typewritten or printed text into machine-encoded/computer-readable text. It is widely used as a form of data entry from some sort of original paper data source, whether passport documents, invoices, bank statement, receipts, business card, mail, or any number of printed records. It is a common method of digitizing printed texts so that they can be electronically edited, searched, stored more compactly, displayed on-line, and used in machine processes such as machine translation, text-to-speech, key data extraction and text mining. OCR is a field of research in pattern recognition, artificial intelligence and computer vision.

Early versions needed to be programmed with images of each character, and worked on one font at a time. "Intelligent" systems with a high degree of recognition accuracy for most fonts are now common. Some commercial systems are capable of reproducing formatted output that closely approximates the original scanned page including images, columns and other non-textual components.

Applications

OCR engine has been developed into many kinds of object oriented OCR applications, such as receipt OCR, invoice OCR, check OCR, legal billing document OCR.

It can be used for:

- Data entry for business documents, e.g. check, passport, invoice, bank statement and receipt
- Automatic number plate recognition
- Automatic insurance documents key information extraction
- Extracting business card information into a contact list
- More quickly make textual versions of printed documents, e.g. book scanning for Project Gutenberg
- Make electronic images of printed documents searchable, e.g. Google Books
- Converting handwriting in real time to control a computer (pen computing)
- Defeating CAPTCHA anti-bot systems, though these are specifically designed to prevent OCR
- Assistive technology for blind and visually impaired users

V. CONCLUSION

In this paper we have studied the optimization of traffic light controller in a City using IR sensors and microcontroller shows the basic block diagram of the system and shows the complete circuit diagram of microcontroller board reduce the possibilities of traffic jams, caused by traffic lights, to an extent and we have successfully gets the results. According to the no. of vehicle sensed by IR the signal timings will be changed. And the vehicle which breaks the traffic rules is captured through camera and the number plate of the vehicle is recognized by using OCR. Then it gives warning message to that vehicle owner. If the same the same vehicle again repeats the same mistake then the complaint is forwarded to near by police control room. So the action is taken against that person who breaks the traffic rules. It is implemented in order to reduce the accidents takes place because of these mistakes.

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