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Application of Sensors for Traffic Management and Coordination

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***Abstract*—Traffic Management involves planning, designing, integration of traffic signal system to achieve efficiency, safety, reliability. Designing of signal system which will provide real time feedback of traffic conditions for dynamic functionality to control traffic signals to optimize traffic management. In this paper, I have used Infrared Transceivers (sensors) for collecting real time data and Microcontroller for processing of data to adjust the Signal Timing**

***Index Terms*—Infrared Transceivers, Microcontroller, Decision Support System**

INTRODUCTION

The need to design an Urban Traffic Management System is to save time and energy, and manage traffic effectively according to traffic patterns and road.

As in day to day life urban traffic has significant impact on life style of citizens. The present traffic management system is hardcoded and not optimized up to the mark. Presently, automatic traffic signals are provided for constant time and they are not adaptive to the traffic density. Every road has its own characteristics about its traffic density at particular time of day. According one survey average person is wasting two weeks out of his whole life for in traffic congestions [1]. As this figures looks not that much problematic but if we talk about day to day life traffic congestions are bottleneck for economic growth as they waste lot of valuable human working hours. Nowadays computational power of computers has increased drastically with decrease in hardware cost. This fact can be exploited for effective and efficient management tools with decision support system and information system.

The conventional model of traffic signals used electromechanical controllers, in which cams, dials, shafts were the controlling elements. Cycle length of signals were adjusted using dial timers i.e. cycle gears. The range of cycle gears used to be from 35 seconds to 120 seconds. An Electrical control is used now days replacing the electro mechanical control. The drawback of conventional system was, it cannot be coordinated with other signals.

The recent technology used in signals is hard wired, hard coded microcontrollers which are programmed to do the task. The signal timings (Green and Red) are hard coded in the microcontroller hence uses no real time feedback about the traffic conditions.

In this paper we are proposing an intelligent, sophisticated, cost effective, economical signal system with DSS, known as Dynamic Control of Traffic Signals, prior to which existing systems are discussed.

EXISTING SYSTEM

Existing systems are those which are discussed earlier and those with dynamic control, but the difference in existing dynamically control and the suggested system is the usage and placement of detector (Sensor). The classes of dynamically controlled system are: [2]

a) In-pavement detectors
b) Non-intrusive detectors

IN-PAVEMENT DETECTORS

These detectors are buried in or under the roadway. Inductive detector loops are the most common type. These sensors are buried in the road to detect the presence of traffic waiting at the light, and thus can sense the traffic density. A timer is frequently used as a default during times of very low traffic density and as a backup in case the sensors fail. The sensor loops typically work in the same fashion as metal detectors. Consequently small vehicles and bicycles or vehicles with low metal content may fail to be detected causing them to wait indefinitely unless there is also a default timer as part of the control system.

NON-INTRUSIVE DETECTORS

It is sometimes more advantageous and cost effective to install over-roadway sensors than cutting the road and embedding inductive loops. These technologies include video image processors, sensors that use electromagnetic waves, or acoustic sensors to detect the presence of vehicles at the intersection waiting for right of way. These over-roadway sensors are more favorable than in-roadway sensors because they are immune to the natural degradation associated with paved right-of-way, competitively priced to install in terms of monetary and labor cost and danger to installation personnel, and have the capacity to act as real-time traffic management devices. They also act as multi-lane detectors, and collect data types not available from in-roadway sensors.

PROPOSED SYSTEM

This type of system is dynamically controlled as stated earlier. The signals are programmed to adjust timing and phasing to meet changing traffic conditions. This system minimizes the delay of vehicle going through the intersection. The control strategy is sensing traffic using detectors, providing information to microcontroller and then microcontroller adjusting signal timings.

The controller uses sensors, here we propose Infrared Transceivers. These sensors inform the microcontroller about the presence of vehicles and number of vehicles on that specific road, and then microcontroller adjusts the signal timing. The controller programming can be done in such a way that, controller can give more timing to a road experiencing heavy traffic or shorten the timing or even skip green signal time.

HARDWARE SYSTEM

The hardware prototype is designed and developed to demonstrate the actual site appearance of road traffic signals. The model is used to visualize the actual road conditions and to illustrate how signal timing changes.

Hardware used in the model -

a) Operational Amplifier (OP-AMP)
b) Infrared Transceivers
c) Opto-Coupler MCT2E
d) Microcontroller (89C51)
e) LCD Display etc

Op-Amp: An operational amplifier, often called an op-amp, is a DC-coupled high-gain electronic voltage amplifier with differential inputs and, usually, a single output. Typically the output of the op-amp is controlled either by negative feedback, which largely determines the magnitude of its output voltage gain, or by positive feedback, which facilitates regenerative gain and oscillation. High input impedance at the input terminals and low output impedance are important typical characteristics. [3]

Op-Amp used in our proposed system is OP-07; The OP07 has very low input offset voltage (75 µV max for OP07E) which is obtained by trimming at the wafer stage. These low offset voltages generally eliminate any need for external nulling. The OP07 also features low input bias current (4 nA) and high open-loop gain (200 V/mV). The low offsets and high open-loop gain make the OP07 particularly useful for high-gain instrumentation applications.

The wide input voltage range of 13V minimum combined with high CMRR of 106 dB (OP07E) and high input impedance provides high accuracy in the non-inverting circuit configuration. Excellent linearity and gain accuracy can be maintained even at high closed-loop gains. Stability of offsets and gain with time or variations in temperature is excellent. The accuracy and stability of the OP07, even at high gain, combined with the freedom from external nulling have made the OP07 an industry standard for instrumentation applications. [4]

Infrared Transceivers: Infrared (IR) radiation is electromagnetic radiation whose wavelength is longer than that of visible light, but shorter than that of terahertz radiation and microwaves. The name means "below red" (from the Latin infra, "below"), red being the color of visible light with the longest wavelength. Infrared radiation has wavelengths between about 750 nm and 1 mm.

IR LED’s are solid state light sources which emit light in the near-IR part of the spectrum. Because they emit at wavelengths which provide a close match to the peak spectral response of silicon photo-detectors, both GaAs (gallium arsenide)and GaAlAs (Aluminum gallium arsenide)IRs are often used with phototransistors.

Like diodes, all transistors are light-sensitive. Phototransistors are designed specifically to take advantage of this fact. The most-common variant is an NPN bipolar transistor with an exposed base region. Here, light striking the base replaces what would ordinarily be voltage applied to the base so, a phototransistor amplifies variations in the light striking it. [5]

Opto-CouplerMCT2E: A common implementation is a LED and a phototransistor in a light-tight housing to exclude ambient light and without common electrical connection, positioned so that light from the LED will impinge on the photo detector. When an electrical signal is applied to the input of the opto-isolator, its LED lights and illuminates the photo detector, producing a corresponding electrical signal in the output circuit. Unlike a transformer the opto-isolator allows DC coupling and can provide any desired degree of electrical isolation and protection from serious overvoltage conditions in one circuit affecting the other. A higher transmission ratio can be obtained by using a Darlington instead of a simple phototransistor, at the cost of reduced noise immunity and higher delay.

With a photodiode as the detector, the output current is proportional to the intensity of incident light supplied by the emitter. The diode can be used in a photovoltaic mode or a photoconductive mode. In photovoltaic mode, the diode acts as a current source in parallel with a forward-biased diode. The output current and voltage are dependent on the load impedance and light intensity. In photoconductive mode, the diode is connected to a supply voltage, and the magnitude of the current conducted is directly proportional to the intensity of light. This opto-coupler type is significantly faster than photo transistor type, but the transmission ratio is very low; it is common to integrate an output amplifier circuit into the same package. [6]

Microcontroller (89C51): The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel’s high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pin-out. The on-chip flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPUwith flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly-flexible and

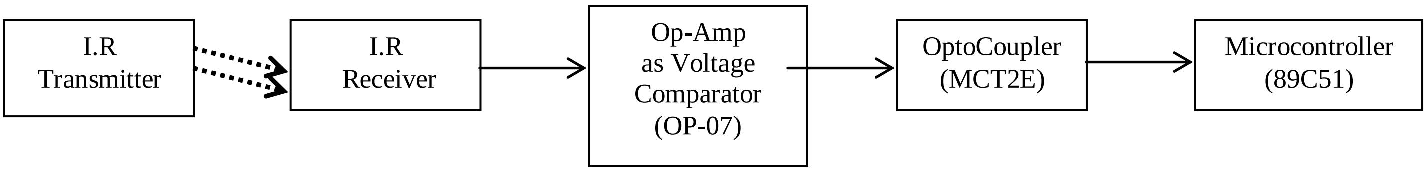

Fig 1 System Overview

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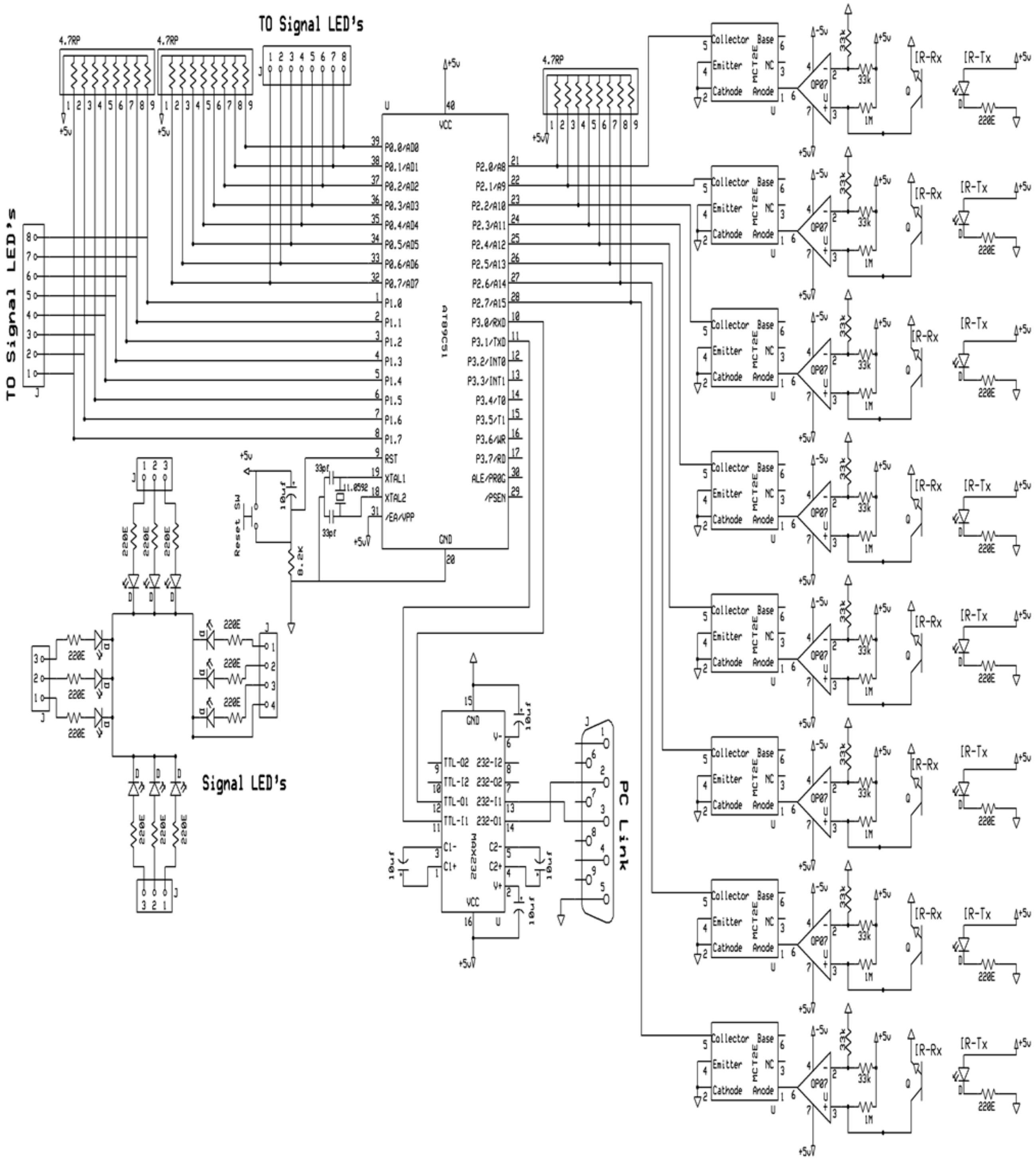

Fig 2: Hardware Prototype

cost-effective solution to many embedded control applications. [7]

WORKING OF PROPOSED SYSTEM

- Opamp OP-07 is used as a voltage comparator in the circuit.
- The positive and negative power inputs of Opamp are fed with +5V and -5V respectively.
- The output of Opamp is connected to the input LED of opto-coupler MCT2E.
- MCT2E in turn has an inbuilt LED as well as an inbuilt photo transistor.
- The inverting terminal of op-amp is continuously fed 2.5V that is obtained from the potential divider network comprising of two resistors of 33K each.
- The non-inverting terminal of Opamp is given an input from collector pin of phototransistor.
- The phototransistor conducts only if infra-red light falls on it.
- The IR LED is connected to VCC via 480 Ohms current limiting resistance.

Two possibilities can occur in case the IR light from IR LED is falling on the photo transistor or not.

A) When the light from IR LED falls on photo-transistor, the transistor conducts. Hence the current from 1M resistance is grounded via phototransistor and there is no voltage at the collector terminal of photo transistor. Hence the non-inverting terminal of Opamp is at 0V. Since inverting terminal is at higher value (2.5V), the Opamp outputs -5V. A negative voltage input at Opto-coupler MCT2E won't forward bias the inbuilt LED. Hence the inbuilt photo-transistor wont conduct and collector pin of inbuilt phototransistor will be at high impedance or tri-stated.

B) When the light from IR LED is blocked, the transistor stops conducting. Hence the current from 1M resistance is not grounded and there is approx. 5V potential difference at the collector terminal of photo transistor. Hence the non-inverting terminal of Opamp is at 5V (approx.). Since inverting terminal is at a lower value (2.5V), the Opamp outputs +5V. A positive voltage input at Opto-coupler MCT2E will forward bias the inbuilt LED. Hence the inbuilt photo-transistor will conduct and ground the collector pin of inbuilt phototransistor.

The output of inbuilt phototransistor can be fed to buffers or any digital interface circuitry for further processing.
The circuit diagram for the hardware prototype is as shown in Fig 2.

CONCLUSION

This technology can be implemented for accurate sensing of Traffic Density; the proposed system is just a prototype for actual system. Further enhancement can be- change in mounting of Sensors, change in sensors to increase the range of sensing.

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