INTELLIGENT TRAFFIC MANAGEMENT SYSTEM: OPTIMIZING TRAFFIC FLOW AND PRIORITIZING EMERGENCY VEHICLES

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Abstract. The project's goal is to build a dynamic traffic signal system based on traffic density, where the timing of the signal will vary automatically when traffic volume at the junction changes in either direction. In this study, a prototype density-based traffic control signal with a Bluetooth-based emergency override is proposed. The recommended system separates the time slots for each route based on vehicle density, providing time control. The project includes priority-based traffic light management for high-density lanes and emergency vehicles. The density-based traffic light system measures traffic volume using IR sensors. An IR sensor is mounted on each road, and it continuously monitors the flow of vehicles. The microcontroller board is interfaced with all of these IR sensors.
Keywords: Traffic density, IR sensors, Microcontroller, Bluetooth Module.

1. Introduction

Because to the fast growth of automobiles and the lengthy intervals between traffic signals, regulating the flow of traffic has become a significant problem in modern times. We shall thus use a system of traffic signals based on density to solve this issue. You will learn in this tutorial how to manage traffic based on density. With this system, the traffic density will be measured using IR sensors. Each road must have one IR sensor, which continually monitors traffic on that route. All these sensors have interfaces with the microcontroller. The controller can detect traffic and operate the traffic system thanks to these sensors.Traffic signal preemption or prioritization can be used to prioritize the regular functioning of traffic signals. By granting the emergency vehicle the right of way and stopping any competing traffic, these systems are most frequently used to change traffic signals in the route of emergency vehicles. This helps to speed up response times and enhance traffic safety. The appropriate traffic analysis and adjusting of traffic management controls can control this issue. The development of a traffic analysis through the use of a microcontroller to measure the density of traffic on a road is one strategy for resolving the traffic issue.

2. EMBEDDED SYSTEM

Installedframeworksarespecializedcomputingframeworksdesignedtoperformoneormorespecifictasksandmayhaveongoingcomputationallimits.Theseareoftenintegratedintocomprehensivedevicesthatalsocontainmechanicalandphysicalparts.Personalcomputers,incontrast,aregeneral-purposecomputersthatcanperformawidevarietyoftasksifproperlyprogrammed.Intoday'sworld,embeddedsystemsareimportantastheymanagemanyofcommondevicesweused daily.
Design engineers can optimize the embedded system, thereby reducing the product size and cost or increasing its reliability. Because of economies of scale, some embedded systems are produced in large quantities.A type of computer called an embedded system is designed to perform a limited number of specified functions, usually within real-time computing. This is typically the functionality of the entire device, which includes hardware as well as mechanical components. On the other hand, general-purpose computers, like personal computers (PCs), are adaptable and created to satisfy a range of end-user demands. Many commonplace items are managed by embedded systems.

3. 8051 MICROCONTROLLERS

A microcontroller is a true computer on a chip, and its architecture includes all the CPU's registers, program counter, arithmetic logic unit, and stack pointer functions. In addition, functions such as RAM, ROM, serial I/O, clock circuit, and counter are installed.

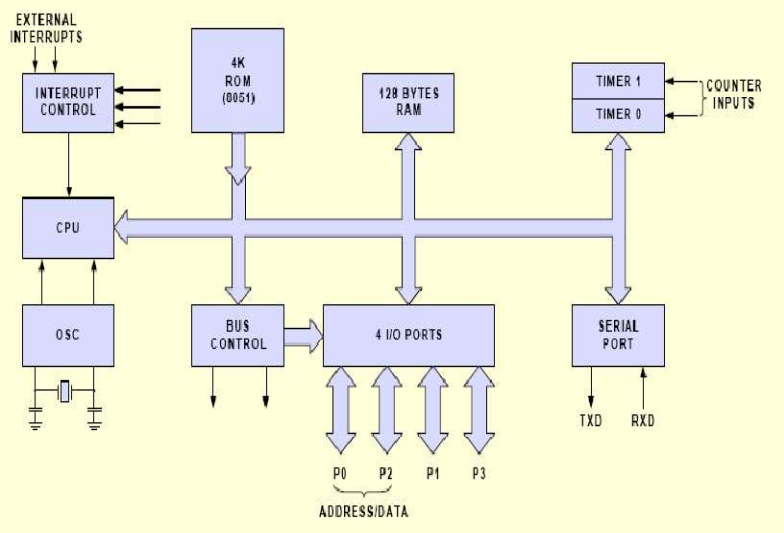
Like microprocessors, microcontrollers are general-purpose devices, but their purpose is simply to read input, perform computations on that data, and use those computations to control the

environment. The best approach to using a microcontroller is with good software that is stored in ROM and controls the machine's behavior without modification during the duration of the system. The microcontroller scheduling approach transfers code and data from internal memory to the ALU with less single and double bytes. The IC package's pins have several instructions linked to them, and depending on the programmer's requirements, the pins can carry out a variety of activities.

3.1 8051 ARCHITECTURE:

An Harvard architecture with two distinct buses for programme and data can be supported by a conventional 8051 design. For data and programmes, it has two independent 64K x 8 memory sections. Based on the 8-bit central processing unit, the primary processing units are an 8-bit accumulation register and an extra 8-bit B register. Furthermore, 8-bit and 16-bit registers and 8-bit memory addresses are included in the architecture.

A RAM data capacity is built into every 8051 device for internal processing. Batch operations and temporary data storage take place in this area.On-chip peripherals including I/O ports, timers, counters, and flexible serial communication interfaces support this bus design. So, it is evident that this8051technology is created to satisfy a number of embedded purposes. AT89S52microcontrollerfeaturesincludeendurance,8KBISPFlashmemory,andcompatibilitywithMCS ®-51products.10,000Write/erasecycles.



Block Diagram of the 8051 Core

The AT89S52 is a high-performance, low-power 8-bit CMOS microcontroller with 8KB of intrinsically programmable Flash memory. The device uses his 80C51 instruction set, which is the de facto industry standard, and is pin compatible with his Atmel high density non-volatile memory technology. The programme memory may be upgraded using the system's on-chip flash or a regular non-volatile memory programmer. High-performance monolithic microcontroller with an 8-bit CPU and built-in programmable memory is the Atmel AT89S52. As a result, it offers many embedded control applications a low-cost and highly configurable choice. The following features are included as standard with the AT89S52:

32 I/O lines, guard dog clock, 2 information pointers, 3 16-digit clocks/counters, 6 vector 2-level barrier design, full-duplex sequentialport, on-chip oscillator, clock hardware, and 8K Bytes Glimmer and 256 Bytes Smash is also included. Additionally, the AT89S52 offers two programmable power saving modes and has static logic for repetitive down to zero activity. The computer's CPU is turned off in idle mode, but slam, clock/counter, sequential port, and intrusion framework continue to work. In power-down mode, the contents of RAM are preserved, but the oscillator is locked, and all other chip activity is suspended until the next interrupt.

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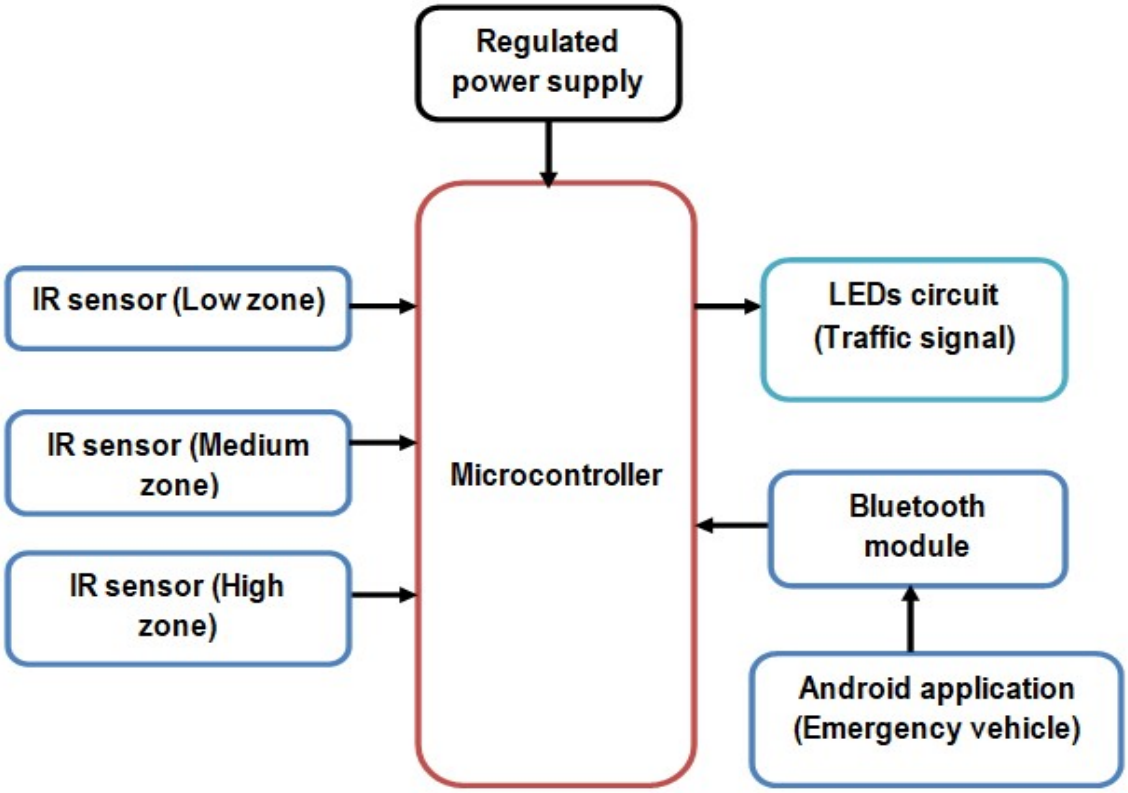
4. HARDWARE IMPLEMENTATION

Block Diagram



Regulated Power Supply:

You can continuously change the outputvoltage of a variable regulated power-supply (also known as variable benchtop power-supply) to suit your needs. After careful consideration of component placement using schematics and component placement guides, we recommend that you test your project by changing the output of your power supply.

This is the perfect adjustment method if you need a hassle-free variable tabletop power supply. This is actually very important, as building a variable control power supply is one of the first things any hobbyist should tackle. Dedicated sources are useful, but flexible sources are much more useful, especially for testing. A 5-volt power source is typically used for microcontrollers. You will need to construct a regulated 5-volt power supply in order to use these parts. We frequently begin with an unregulated power source. It provides a 5-volt power supply (integrated circuit) using a 7805 voltage regulator chip.

IR Sensor:

An electronic sensor is a gadget that produces infrared radiation to pick up particular details about its surroundings. IR sensors have the ability to monitor movement and track an object's temperature. Since they don't emit infrared light, these sensors are known as passive IR sensors. Simply measure where it belongs. Infrared heat radiation is normally emitted in some form by everything. Infrared sensors can detect this radiation even if it cannot be seen with the human eye. The emitter is an IR LED (Light Emitting Diode), and the detector is an IR photodiode that is sensitive to IR light with the same wavelength as the IR LEDs. The output voltage and resistance of a photodiode that has received IR light vary in direct proportion to the amount of IR light that was received.

This circuit contains the following components:

- Pair of IR emitter and receiver chips (LM358)
- Kilo-ohm resistors.
- Different resistances.
- LED.

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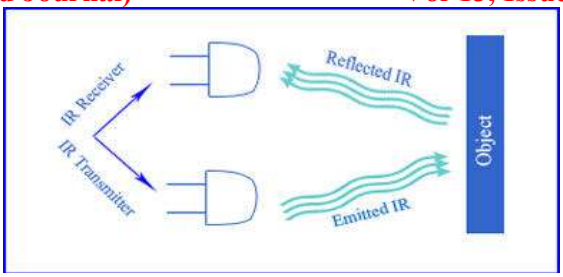
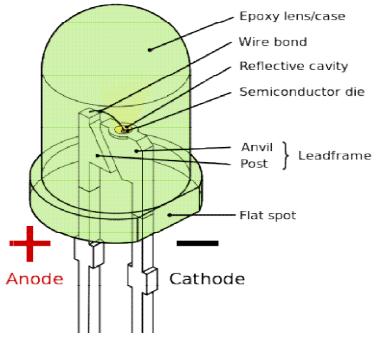


LED:

A semiconductor light source with two terminals is known as an LED. a PN junction diode that lights up when activated. By recombining with holes inside the device, electrons release energy in the form of photons when a proper voltage is given to the terminals. The energy bandgap of the semiconductor, which corresponds to photon energy, controls the colour of the light in electroluminescence, a phenomena. LEDs can employ integrated optical components to modify the emission pattern while frequently being very tiny (less than 1mm2). When the first LEDs were introduced as practical electrical components in 1962, they let out low-intensity infrared radiation. As transmitting elements in remote control circuits, such as in the remote controllers for different consumer electronics, infrared LEDs are still often utilised.Early visible light-producing LEDs were likewise underpowered and only generated red light. Modern LEDs can emit light in the visible, ultraviolet, and infrared spectrums and are quite bright.



Bluetooth Module:

The Arduino BT board and the Android mobile phone are the two primary components of this project. The Android smartphone comes with a number of Bluetooth apps that let the user use the voice guider when necessary. We are focusing on the Android platform in this project because of its large market and open source nature. The Android software stack for mobile devices consists of an operating system, middleware, and significant apps. Based on Linux, the Android OS is used. Android applications are written in a language similar to Java and operate on Google's virtual engine, dubbed "Dalvik." The Android SDK provides the tools and APIs needed to begin developing Java-based Android apps. Since Android OS versions 2.3.4 Gingerbread and 3.1 Honeycomb and above, accessory mode has been a feature.

The primary purpose of the programme is to operate motors via drive circuits according to command input from an Android device.

The packets transmitted from the Android device (cell phone) are received by the Bluetooth module. The microcontroller and the specified analogue circuitry then pipe these packets holding the appliance status directives in accordance with the specification of each output. To activate a certain speech chip channel, a voice chip is linked by transistors to the controller's digital output ports. For demo purpose 8 channel voice record cum playback chip is used that can announce a maximum of 8 messages only. Sending commands from software (android device) will turn ON the channel of the voice chip that will be announced through the speaker.

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The VCC (5v), GND, RX, and TX pins are the only ones needed to link your Bluetooth module. For serial communication, the Transmitter and Receiver pins of the microcontroller are shorted to the RX and TX pins, respectively. The remaining pins on the Bluetooth module can be disregarded. If not, consult the datasheet for the module for the pin names, which are located on the bottom of that board. It's simple to link the power supply's (+Vcc and Gnd) straight into the VCC and GND power lines. Through AT instructions, the controller talks with the Bluetooth module. In later chapters, further information on Bluetooth technology is offered.

The data is modulated and transmitted based on the commands from the remote, which will be demodulated by the Bluetooth module on the warfare vehicle, and is fed to the arduino micro controller. The controller decodes the data and performs the required action in accordance with the programming contained therein. The vehicle movement can be controlled with the DC motors that will be interfaced to the controller through the H-bridge IC L293D. By using this IC, we will interface the controller to the H-bridge.

5. WORKING PRINCIPLE

Here is a detailed description of how the system operates:

Installation of Sensors: To keep an eye on the density of cars, sensors are strategically positioned close to the intersection. There are infrared sensors here.

Density Calculation: A central control unit (Microcontroller) receives the information from the sensors that identify the presence of cars. To determine the vehicle density at the junction, the control unit analyses input from several sensors.

Traffic Light Control Algorithm: Based on the density of cars, the control unit applies a traffic light control algorithm to select the best signal timings. The algorithm seeks to reduce gridlock and increase the effectiveness of traffic movement.

Emergency Vehicle Detection and Priority Clearance Mechanism: The junction has the Bluetooth module fitted. The Bluetooth module on an emergency vehicle transmits a signal to the control unit as it approaches the junction, alerting it to its presence and the requirement for priority clearance. The control unit alters the timings of the traffic lights to grant the emergency vehicle priority clearance after receiving the signal from the emergency vehicle. This entails giving the emergency vehicle a green light as it approaches and slowing down or changing the timing of the signals for other directions to make way for it safely and swiftly.

Reverting to Normal Operation: The control unit switches back to the standard traffic signal control algorithm based on the density of cars once the emergency vehicle has passed through the junction. To improve traffic flow, the system may dynamically modify the signal timings in response to shifting traffic circumstances.

The control unit adjusts the signal timings in response to the sensors' continual monitoring of the traffic density. This enables real-time traffic flow optimisation and system adaptation to changes in traffic patterns.

6. CONCLUSION

This project on a density-based traffic light management system using Bluetooth modules has successfully solved the problem of traffic congestion by maximizing traffic flow. By using a density-

based algorithm and a Bluetooth module, the system can effectively determine the density of cars at intersections and change the timing of traffic lights.

This project has many important advantages. First, it improves traffic efficiency by dynamically adjusting signal times based on actual vehicle density at each intersection. This reduces waiting times and avoids unnecessary traffic jams. Second, the integration of the Bluetooth module enables efficient communication between vehicles equipped with Bluetooth devices and traffic light management systems. This allows emergency vehicles to be prioritized, improving overall safety and response time.

7. REFERENCES

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