International Journal of Science Engineering and Advance Technology

Automatic Traffic Lights Control Using ARM7 Based On CO_2 Emissions

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Abstract—

Monitoring and controlling of city traffic is becoming a difficult task in most of the city. With the ever increasing number of vehicles on the road, the Traffic Monitoring Authority has to find new methods of overcoming such a problem. Present Traffic Light Controllers (TLCs) is based on microcontroller and microprocessor which have limitations because it uses the pre-defined hardware, which is functioning according to the program that does not have the flexibility of modification on real time basis Due to the fixed time intervals of green, orange and red signals the waiting time is more and vehicle uses more fuel. This proposed project makes use of Networks along with Embedded Technology. This paper aims to design a safe and efficient traffic flow by reducing the effect of CO_2 emitted from vehicles at that region and assign the right way which minimizes the delay or waiting time at road.

The CO_2 level emitted from vehicles in all directions will be transmitted through CO_2 sensor we used in our system which is to sense the Carbon di-oxide emissions from the vehicles. The receiver at the TLC will receive the information. The information from all directions is transmitted and received through the Zigbee wireless communication. Based on CO_2 levels, the traffic light indication will be given in the appropriate directions. The status will be shown in LCD and SMS alert will be sent to the Traffic Control Room using Global System for Mobile Communications (GSM).

***Keywords*— Intelligent Transportation Systems (ITS), Traffic Light Controller (TLC), CO_2, Zigbee, Global System for Mobile Communications (GSM).**

I INTRODUCTION

In the fast emerging world, vehicles become mandatory for all purposes. Increased car use and road goods movements have highlighted not only the problem of congestion as a threat to economic growth but also as a substantial contributor to global warming[4].

The vehicle emissions [2] pollute the atmosphere thereby leading to many hazardous effects. Traffic consumes energy, and generates noise and harmful emissions. The quality of the air we breathe is diminished mainly by traffic emissions, because the exhaust emissions are released at a low level. Carbon dioxide emissions from traffic are a worldwide problem. Vehicular traffic is the main source of disturbing environmental noise. With the increase in the amount of traffic the noise carries increasingly greater distances.

The Intergovernmental Panel on Climate Change (IPCC) is correct about man-made CO_2 causing temperature increases with melting of ice caps and sea level rises. IPCC claims they are now 95% certain global warming is being caused by increasing CO_2 from human activity. It was set up in 1988 by a small group of scientists who were already convinced that rising CO_2 levels were the prime factor in global temperature rise.

The long-term objective of the European Union climate policy is to prevent global mean temperature rising by more than 2°C over pre-industrial levels. To achieve this target, developed countries and regions, including the EU, should reduce their emissions by 60–80 % over the period 1990–2050. Without policy induced constraints this target will be missed by a substantial margin. According to model-based estimates and projections, if no further action to control emissions is taken,

concentrations of greenhouse gas in the atmosphere may increase from 425 parts per million volume (ppmv) CO_2-equivalent today to 935 ppmv CO_2-equivalent in 2100. This could cause global temperature to rise by more than 3°C by 2100.So it becomes essential need to develop a system which reduces the emission of CO_2 from vehicles. This project involves a real time traffic lights control scheme for reducing vehicular CO_2 emissions[3]. Real time CO_2 emission values are obtained by wireless communication. Usually, vehicles follow stop-and-go[6] driving scheme. This will consume more fuel and emit more CO_2 than constant speed driving. After smoothing vehicles' travels, more vehicles can pass intersections with less waiting time and fewer short-time stops. This results in drastic reduction of vehicular emissions. The average waiting time, and the effect of vehicular emissions on the environment & public on road is greatly reduced by this project This project consists of two ARM7TDMI based LPC2148 microcontrollers, ZIGBEE Transmitter and Receiver, Power Supply Relay Circuits, CO_2 sensors, Buzzers, GSM & Traffic Lights.

In this system we are going to interface CO_2 sensors, driver circuits with relays and ZIGBEE transmitter and a buzzer with the Microcontroller at the Transmitter Section attached at the road divider. The Zigbee transmitter transmits the CO_2 levels. And in the Receiver section at the Traffic Lights we are going to interface GSM, Buzzer, Zigbee. Receiver section controls the traffic lights by what it receives from the Zigbee signal. Traffic Lights were to release the signal & GSM modem, to send the SMS alerts and to change the time interval of traffic lights in normal conditions

II PROPOSED SYSTEM DESIGN AND COMPONENTS

The Hardware architecture depicts the proposed design of an embedded Traffic Control System that includes Transmitter and Receiver sections which were shown in the figures 1.1 &1.2. The elements of the system consist of various subsystems. The microcontroller, power circuitry, Zigbee system, GSM and CO_2 sensors, are the crucial systems. The proposed system can be designed and the transmitter section can be mounted at the road side whereas the receiver section at the traffic lights. This requires a clear vision of the desired system goals. Various system parameters are thus needed to be evaluated based on the design to be practically implementable.

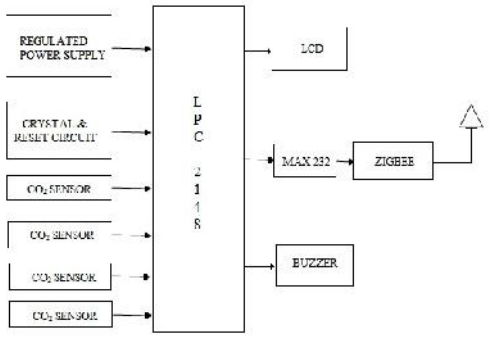


Figure1.1 Transmitter Section

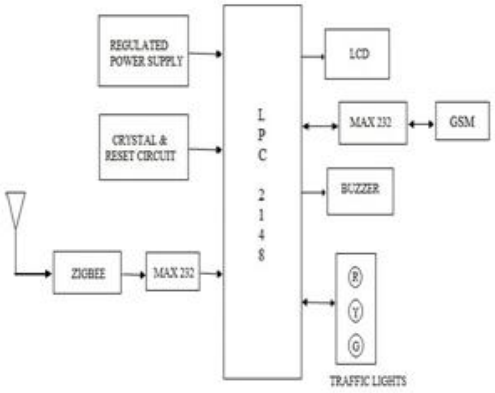


Figure 1.2 Receiver Section

MICROCONTROLLER: The microcontroller used in the Transmitter and Receiver Sections with user input interface can be preferably ARM7TDMI based LPC2148 microcontroller, which is having 512KB flash memory and 8 to 40 KB of SRAM and several peripherals. The ARM7TDMI-S is a general purpose 32-bit microprocessor. A unique accelerator architecture and a 128-bit wide memory interface enable 32-bit code execution at the maximum clock rate.

GSM MODULES: Global System for Mobile communications (GSM) are interfaced to the microcontroller to send the SMS alerts and to change the time interval of traffic lights in normal conditions. The time interval will be set and will be sent by the authorized person to the GSM placed at the Traffic Lights Controller.

CO_2 SENSORS: It senses the Carbon di-oxide emissions from the vehicles.

LCD: The status of CO_2 levels will be shown on LCD.

BUZZER: Whenever the CO_2 level crosses the threshold limit then buzzer will give indication at the transmitter side and at the receiver side, at the time of releasing the signal it will work.

ZIGBEE TECHNOLOGY: The levels of CO_2 emitted by vehicles from all directions is transmitted and received through the Zigbee wireless communication. The Zigbee will communicate using RS232 protocol with microcontroller II HARDWARE DESIGN

ARM ARCHITECTURE:

The ARM core uses RISC architecture[9]. Its design philosophy is aimed at delivering simple but powerful instructions that execute within a single cycle at a high clock speed. The RISC philosophy concentrates on reducing the complexity of instructions performed by the hardware because it is easier to provide greater flexibility and intelligence in software rather than hardware. As, a result RISC design plays greater demands on the compiler. In contrast, the traditional Complex Instruction Set Computer (CISC) relies more on the hardware for instruction functionality, and consequently the CISC instructions are more complicated.

FEATURES:

- 32/16-bit RISC architecture (ARM v4T)
- 32-bit ARM instruction set for maximum performance and flexibility
- 16-bit Thumb instruction set for increased code density
- Unified bus interface, 32-bit data bus carries both instructions and data
- Three-stage pipeline
- 32-bit ALU
- Very small die size and low power consumption
- Fully static operation
- Coprocessor interface
- Extensive debug facilities (Embedded ICE debug unit accessible via JTAG interface unit)

ADVANTAGES:

- Generic layout can be ported to specific process technologies
- Unified memory bus simplifies SOC(System on chip) integration process
- ARM and Thumb instructions sets can be mixed with minimal overhead to support application requirements for speed and code density
- Code written for ARM7TDMI-S is binary-compatible with other members of the ARM7 Family and forwards compatible with ARM9, ARM9E and ARM10 families, thus it's quite easy to port your design to higher level microcontroller or microprocessor
- Static design and lower power consumption are essential for battery -powered devices
- Instruction set can be extended for specific requirements using coprocessors
- Embedded ICE-RT and optional ETM units enable extensive, real-time debug facilities

ZIGBEE:

ZigBee is a technology of IEEE 802.15.4 Protocol. Zigbee Protocol layers are shown in figure 2.1. Low complexity, low cost, low power consumption, low transmitting rate, high reliability, wireless short distance transmission (compared with global Internet), and being capable of ad-hoc networks are all its features. It is suitable for the fields of automatic control and remote control, and it can be embedded in many different devices. In short, ZigBee[7] is a wireless ad-hoc networks capable communication technology which is cheap and low power consumption. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range.

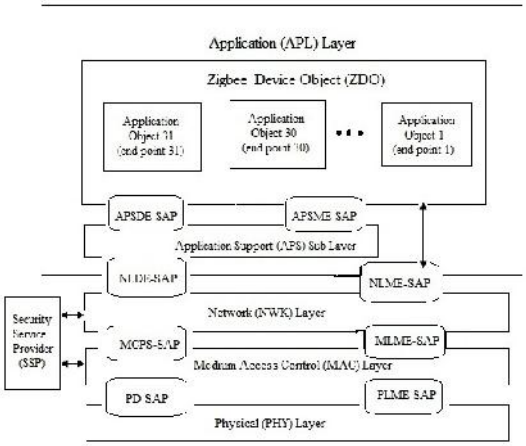
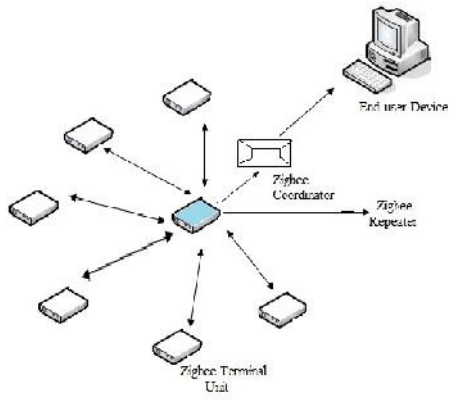


Figure 2.1: Zigbee protocol layers

The principle of ZigBee is not very complex. Devices using ZigBee technology can automatically connect to other devices around them. Those devices form a lot of data paths, so different nodes can transfer their information to the end-users through the different paths. A simple ZigBee network is shown in below figure 2.2.



2.2. A Simple ZigBee Network

The ZigBee Alliance, the standards body that defines ZigBee, also publishes application profiles that allow multiple OEM vendors to create interoperable products. The current list of application profiles are:

- Home Automation.
- ZigBee Smart Energy
- Commercial Building Automation
- Telecommunication Applications
- Personal, Home, and Hospital Care
- Toys

CO_2 SENSORS:

Sensitive material of MQ-7 gas sensor is SnO2, which with lower conductivity in clean air. It make detection by method of cycle high and low temperature, and detect CO_2 when low temperature (heated by 1.5V). The sensor's conductivity is more higher along with the gas concentration rising. When high temperature (heated by 5.0V), it cleans the other gases adsorbed under low temperature. The below figure 3 shows the CO_2 sensor

Figure 3: CO_2 Sensor

MQ-7 gas sensor has high sensitivity to Carbon Monoxide and Carbon dioxide. The sensor could be used to detect different gases contains CO_2, it is with low cost and suitable for different application.

Character Configuration:

- Good sensitivity to Combustible gas in wide range
- High sensitivity to Natural gas
- Long life and low cost
- Simple drive circuit

Applications:

- Domestic gas leakage detector
- Industrial CO detector
- Portable gas detector

LIQUID CRYSTAL DISPLAY:

These components are "specialized" for being used with the microcontrollers, which means that they cannot be activated by standard IC circuits. They are used for writing different messages on a miniature LCD. A model described here is for its low price and great possibilities most frequently used in practice. It is based on the HD44780 microcontroller (Hitachi) and can display messages in two lines with 16 characters each . It displays all letters of alphabet, greek letters, punctuation marks, mathematical symbols etc. In addition, it is possible to display symbols that user makes up on its own. Automatic shifting message on display (shift left and right), appearance of the pointer, backlight etc. are considered as useful characteristics.

GSM:

Global System for Mobile Communications GSM[15] is a digital wireless network standard designed by standardization committees from major European telecommunications operators and manufacturers. The GSM standard provides a common set of compatible services and capabilities to all mobile users across Europe and several million customers worldwide. The GSM Modem is shown in figure 4. The basic requirements of GSM[15] have been described in five aspects.

Figure 4: GSM Modem

Services: The system shall provide service portability, i.e., mobile stations or mobile phones can be used in all participating countries. The system shall offer services that exist in the wire line network as well as services specific to mobile communications. In addition to vehicle-mounted stations, the system shall provide service to Mss used by pedestrians and /or on board ships.

Quality of Services and Security: The quality for voice telephony of GSM shall beat least as good as the previous analog systems over the practical operating range. The system shall be capable of offering information encryption without significantly affecting the costs to users who do not require such facility. Radio Frequency Utilization .the system shall permit a high level of spectrum efficiency and state-of-the-art subscriber facilities. The system shall be capable of operating in the entire allocated frequency band, and co-exist with the earlier systems in the same frequency band.

Network: The identification and numbering plans shall be based on relevant ITU recommendations. An international standardized signalling system shall be used for switching and mobility Management. The existing fixed public networks should not be significantly modified.

Cost: The system parameters shall be chosen with a view to limiting the cost of the complete system, in particular the Mss.

IV SOFTWARE DESIGN AND DEVELOPMENT

The software [11] we use here is Keil µvision 4
IDE (Integrated Development Environment) .This is a virtual platform where we can execute code and check our desired results. For executing the code we have to choose the controller LPC 2148. After checking the results virtually we will dump the code into controller to verify results.

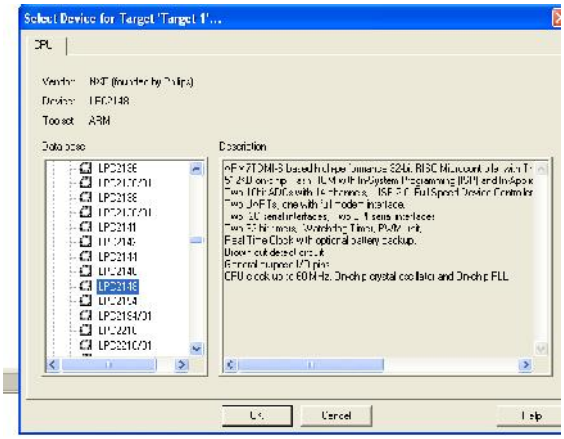


Figure 5: Selection of LPC 2148 in KEIL

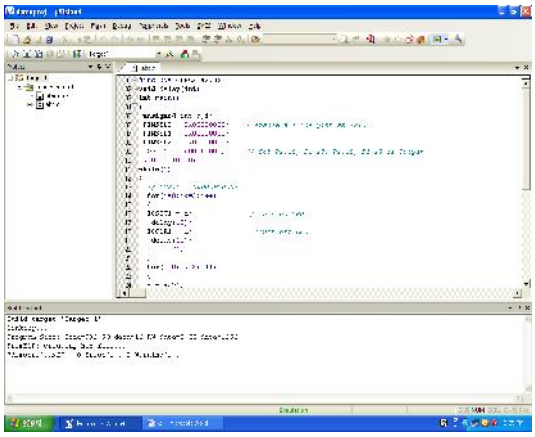


Figure 6: Verifying code for bugs in KEIL

V RESULT

When the traffic on the road increases then the emission of CO_2 from vehicles also increases. The

CO_2 sensors sense the values and this will be stored in LPC2148. CO_2 values from all sides will be compared with the threshold value. If the CO_2 level crosses the threshold then the buzzer will give the indication and those values are transmitted through Zigbee. The receiver at the Traffic lights will receive the information through the Zigbee wireless communication and traffic light indication will be given in that appropriate direction. The status will be shown in LCD and SMS alert will be sent to the Traffic Control Room using Global System for Mobile Communications (GSM). If the traffic is very less then this system will be worked on fixed time interval. This time will be set by messaging that time interval eg:60µs to GSM module. Now, the traffic light controller will give the signal based on the timing.

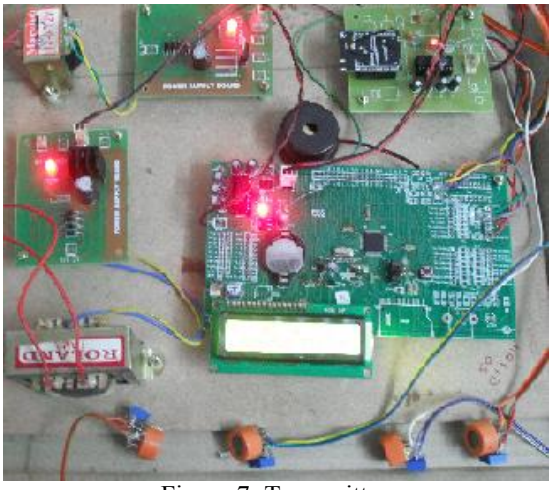


Figure 7: Transmitter

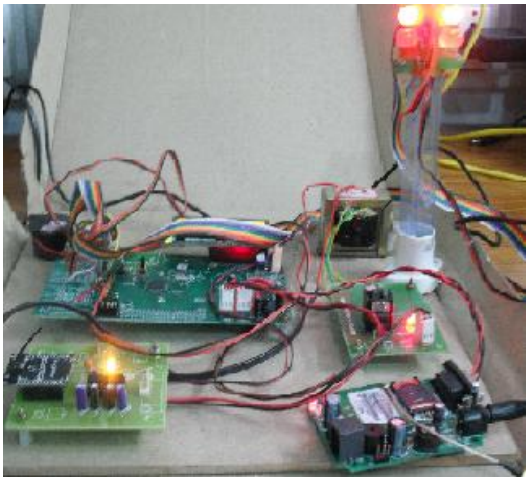


Figure 8: Receiver

VI CONCLUSION

The design and architecture of a new concept of Traffic Lights Control System is very Efficient and can be used as a replacement for the Present Traffic System.By using this System, we can effectively reduces the traffic congestion and CO_2 emissions resulting in reduced Air Pollution. The proposed combination of various working units makes a real-time system that reduces the effects of CO_2, waiting time of vehicles and Fuel efficiency for vehicles is maintained by reducing the Traffic Lights time interval through SMS.

VII FUTURE SCOPE OF THE PROJECT

The methodology of controlling the vehicle movement at TLCs using GSM and CO_2 levels employed in this project for controlling the effects of vehicular emissions, can be used in the future with small improvements for Traffic System using GPRS by which Fuel consumption and/or emissions could be monitored and wherever the vehicle may be, feedback will be given to optimise driving style and vehicle behaviour, for controlling the robots in military applications such as bomb diffusion where humans find it difficult to work.

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