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Smart Wi-Fi Traffic Assister

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Abstract*—Advancements of technology in mobile communications along with wide penetration in usage of Smart phones and its applications as well as increase in traffic densities at junctions in every major city leads to the development of Smart Wi-Fi Traffic Assister with signal overriding using RFID technology. The main purpose of such system is to alleviate the traffic congestion at the junctions by sending traffic density information from junction to Smartphone using Wi-Fi technology. The proposed system placed at traffic junction uses four sets of red, yellow and green LEDs, four IR sensors, RFID reader, Wi-Fi module all these connected to an ARM7 LPC2148 microcontroller. The IR sensor contains IR transmitter and IR receiver each one is placed on either sides of road like this we place all the IR sensors in a four road junction. The on and off condition of this IR sensor gives the density information at a particular road. Based on current traffic density at the four road junction, the microcontroller takes decision and updates the traffic light delays. The RFID technology is used to override the traffic signal if there is any emergency vehicle like ambulance, fire engine or VIP vehicle etc with an RFID tag at any road in a four road junction then the RFID reader reads the RFID tag and sends this signal to microcontroller then the green LED glows for that particular road. All the signals which cause change in normal operation of traffic signalling are continuously sent to users by Wi-Fi module and the user will get the traffic updates whenever required to his/her smart phone through a telnet application.

Keywords — *LED (Light emitting diodes), RFID tags, traffic congestion, IR (Infra red) sensors, TELNET application*

I. INTRODUCTION

Increasing Smartphone penetration along with the migration of citizens from villages to cities for better career opportunities leads to increase in population every year in major cities. With the growing number of vehicles, the traffic densities increases day by day at every junction leads to traffic congestion and transportation delay on every major cities and urban arterials are increasing worldwide. The traffic congestion deteriorates the quality of life of citizens and contributes significantly to environmental pollution. The traffic congestion can also be caused by large Red light delays, the delay of respective light is hard coded in the present traffic light signalling system and it is independent on the current traffic conditions. Therefore it is practically important to develop, verify and validate simple yet powerful models that help in designing and improving the safety and efficiency of transportation. In this paper the optimization of traffic light controller in a City using microcontroller is done. The proposed system i.e., "Smart Wi-Fi Traffic Assister" aims at solving this traffic congestion problem and also tries to reduce possibilities of traffic jams, caused by traffic lights, to an extent by collecting the traffic data and sending the density information to Smartphone using Wi-Fi technology.

The microcontroller used in the system is ARM7 LPC2148. This system contains four sets of red, yellow and green LEDs placed at four road traffic junction, four IR sensors each with an IR transmitter and IR receiver which are mounted on the either sides of roads respectively, RFID reader and Wi-Fi module. The IR system gets activated whenever any vehicle stays on road between IR transmitter and IR receiver which gives the density information in a particular road. In practice we place number of IR sensors mounted on a particular road at equal distances along the length of that road to some extent.

Microcontroller controls the IR system when the IR sensor sends its on and off signals to microcontroller then it sends the response by glowing green LED to that particular road where the IR sensor gets activated. Microcontroller also sends these signals to Wi-Fi module. Based on current traffic density at the four road junction, the microcontroller takes decision and updates the traffic light delays and sends this information to smart phone through the use of Wi-Fi module as a result. The RFID reader is situated at a certain distance from the traffic light controller at every road**.** The RFID technology is used to override the traffic signal if there is any emergency vehicle like ambulance, fire engine or VIP vehicle etc with an RFID tag at any road in a four road junction then the
RFID reader reads the RFID tag and sends this signal to microcontroller then it responds by glowing the green LED for that particular road. All the signals which cause change in normal operation of traffic signalling are continuously sent to the user by Wi-Fi module and thereby the user will get the traffic updates whenever required through his/her smart phone with a telnet application.

Thus based on vehicle density, microcontroller defines different ranges for traffic light delays and updates those accordingly. The system records vehicle density i.e., the IR sensor ON and OFF condition in its memory and allocates predefined recording interval on real time basis. This recorded traffic density data can also be used to analyse traffic condition at respective traffic lights connected to the system. Thus administrator on a central station computer and smart phone user can access traffic conditions on any

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approachable traffic lights and nearby roads i.e., with in the Wi-Fi signal range to reduce traffic congestions to an extent. In future if we implement this TIS in every traffic junctions in all major cities it can be used to inform people about the traffic condition at different places by using advanced networks for communication.

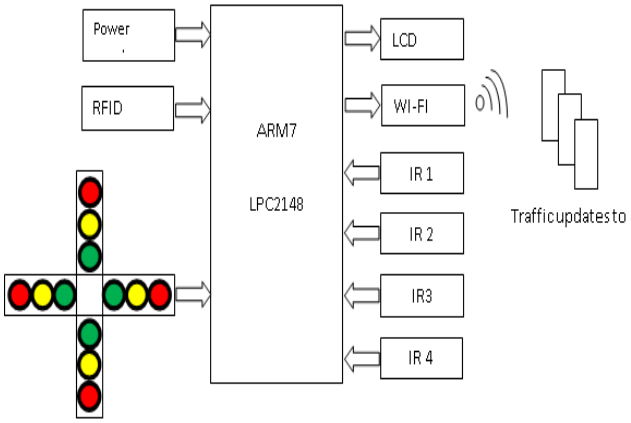

Fig.1 Block diagram of Smart Wi-Fi Traffic Assister

II. IMPLEMENTATION OF THIS SYSTEM

In the design of this system the microcontroller used is ARM7 LPC2148 along with this the system contains power supply, four sets of red, yellow and green LEDs placed at four road traffic junction, four IR sensors each with an IR transmitter and IR receiver which are mounted on the either sides of roads respectively, RFID reader, LCD and Wi-Fi module. The IR system gets activated whenever any vehicle stays on road between IR transmitter and IR receiver which gives the density information in a particular road. The RFID technology is used to override the traffic signalling and LCD is used to display the traffic density information at every change in normal operation of the traffic signalling. The Wi-Fi module ESP8266 is used to send signals i.e., density information which is displayed on LCD from microcontroller to smart phone users through the use of Telnet application.

A. ARM LPC2148 Microcontroller

ARM is an acronym for advanced RISC machine and is manufactured by Phillips. ARM7 is based on reduced instruction set computing architecture. ARM7 is most successful and widely used processor family in embedded system applications. The advantage of low power consumption and low cost increases the range of applications from portable devices to almost all embedded electronic market. It is preloaded with many in-built features and peripherals making it more efficient and reliable choice for an high end application developer.

It also supports both 32-bit and 16-bit instructions via ARM and THUMB instruction set.
The major features of ARM7 LPC2148 microcontroller are

- The Memory of LPC2148 has 40KB on-chip SRAM, 32KB RAM and 512KB on-chip flash program memory.
- It has two IO ports each of 32-bit wide, provided by 64 IO pins. Ports are named as P0 and P1.
- The LPC2148 has two functionally identical general purpose timers: Timer0 and Timer1. These both timers are 32-bit along with 32-bit presaler.
- LPC2148 ARM7 core supports two UART in it, UART0 and UART1. UART0 can be used as general purpose UART and also can support ISP Programming through it, whereas UART1 has additional modem support.
- LPC2148 supports two fast I2C-buses (I2C0 & I2C1). It Supports programmable clock to allow adjustment of multiple data speed: standard (100 kbps), fast (400 kbps) and high speed (3.4 Mbps) and also supports bi-directional data transfer.
- It also supports another two serial interfaces SPI and SSP with buffering and variable length capabilities.

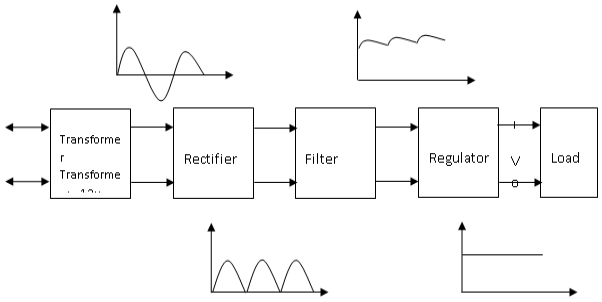

Fig.2 Block Diagram of Power Supply

- USB 2.0 Full Speed compliant Device Controller with 2kB of endpoint RAM. In addition it also provides 8 kB of on-chip RAM accessible to USB by DMA.
- The PWM in LPC2148 is capable of producing six channels of single edge controlled PWM or three channel of dual edge controlled PWM. The Phillips LPC2148 has 6 channels of pulse width modulation. There are 7 registers to accommodate the PWM.
- LPC2148 has two inbuilt 10-bit successive approximation ADC Modules with operating frequency 4.5 MHz (max.)
- It has single 10-bit DAC which provides variable analog outputs.
- The AMBA (**A**dvance **H**igh Performance **B**us) is used for interface vectored interrupt controller to the ARM7 LPC2148.
- On-chip integrated oscillator operates with an external crystal in range from 1 MHz to30 MHz and with an external oscillator up to 50MHz.
- Power saving modes include idle and Power-down.

B. Power Supply

The input to the circuit is applied from the regulated power supply. The AC input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating DC voltage. So in order to get a pure DC voltage, the output voltage from the rectifier is fed to a filter to remove any AC components present even after rectification. Now, this voltage

is given to a voltage regulator to obtain a pure constant DC voltage.

C. Light Emitting Diodes

A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for other lighting. Early LEDs emitted low-intensity red light, but modern versions are available across the visible, ultraviolet and infrared wavelengths, with very high brightness.

When a light-emitting diode is forward biased, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the colour of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor. An LED is often small in area (less than 1 mm^2), and integrated optical components may be used to shape its radiation pattern. LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved robustness, smaller size, faster switching, and greater durability and reliability. Most materials used for LED production have very high refractive indices. This means that much light will be reflected back into the material at the material/air surface interface.

D . Infrared Sensor

An infrared sensor is an electronic device, that emits infrared rays continuously by the IR transmitter. The IR sensor contains IR transmitter and IR receiver. The IR transmitter of infrared sensor is simply an IR LED (light emitting diode) which transmits infrared light but it is not visible to the necked eye. The IR receiver of infrared sensor is simply an IR photodiode which is sensitive to IR light of same wavelength as that emitted by the IR transmitter. When IR light falls on the IR photodiode the resistance and output voltage changes in proportion to the magnitude of the IR light received. An IR sensor is used to measure the heat of an object as well as it detects the motion and which can also be used to detect obstacles. These applications are most common in real time which makes the IR sensor module very popular. IR sensors are of different types based on the application. They are speed sensors for synchronizing the speed of multiple motors, the temperature sensors for industrial temperature control and proximity IR sensor for automatic door opening and ultrasonic sensor for distance measurement.

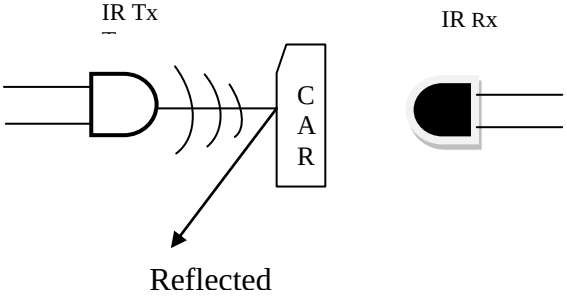

Fig. 3 IR sensor operation in TIS

Infrared radiation is the region having wavelengths longer than visible light wavelengths in the spectrum i.e., from 0.75 to 1000µm. The wavelength region from 0.75 to 3µm is termed as near infrared, the region from 3 to 6µm is termed mid-infrared, and the region higher than 6µm is termed as far infrared. In this system IR transmitter and receiver are placed on either side of the road at some distance from the traffic controller where IR Rays passes between the transmitter and receiver continuously. Whenever a vehicle passes between the transmitter and receiver, it blocks the IR rays to pass from transmitter to receiver. So whenever a vehicle blocks the IR rays, the IR sensor consider it as the density of the traffic for a regular interval of time in this manner it senses the sensor signals and sends the information to the microcontroller which is then displayed in the form of message in LCD and this above procedure continues for regular intervals of time.

E. Radio Frequency Identification

RFID technology is an automated data collection technology. It uses radio frequency waves to transfer data between a reader and a movable item or RFID tag to identify, categorize or track which depends on the requirement of the application. It is fast, continuous process and does not require any physical sight or contact between reader/scanner and the tagged item. It performs the operation using low cost components and attempts to provide unique identification and backend integration that allows wide range of application areas like medical science, commerce, security, Electronic toll collection system, access control etc.

There are three main components of RFID: RFID tag, RF Reader and Database. Various types of tags are available but we can mainly divide them into two categories: passive tags and active tags. The passive tags don't contain any internal power source and has lower storage capacities (few bits to 1KB). These tags have shorter read ranges typically from 4 inches to 5 feet and are usually write once-read many/read only tags. Whereas active tags are battery powered and has higher storage capacities up to 512KB and reader reads from long range up to 300feet.

There are three parts of the tag: antenna, semiconductor chip and some form of encapsulation. The life of the passive tag is very long. The reader sends electromagnetic waves that produce current in the tag's antenna. In response antenna reflects the information stored in it. The active tags contain a battery as an internal power source used to operate microchip's circuitry and to broadcast the information to the reader. The range and cost of these tags is more as compare to passive tags.

We have three kinds of tags which work on the three different frequency ranges: low – frequency, high-frequency and ultra high frequency. The Low frequency tags works on frequency lies between 30 ~ 300 KHZ and High Frequency and Ultra High Frequency Tag works on the frequency range lie 3 ~ 30 MHZ and 300 ~ 3 GHZ respectively.

The figure shows the working of RFID technology in this proposed Smart Traffic Assister system. Whenever RFID

reader reads RFID tag these signals are send to microcontroller and are sent to Smartphone through Wi-Fi.

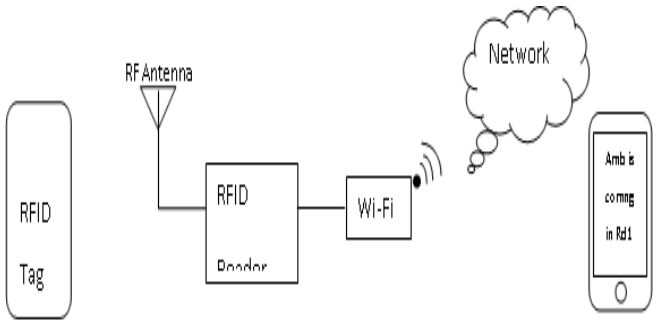

Fig. 4 Working of RFID in Smart Wi-Fi Assister

F. Wi-Fi Technology

EPS8266 module is an impressive, low cost and is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network i.e., this Wi-Fi module is suitable for adding Wi-Fi functionality to an existing microcontroller via a UART serial connection. It is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much Wi-Fi-ability as a Wi-Fi Shield offers.

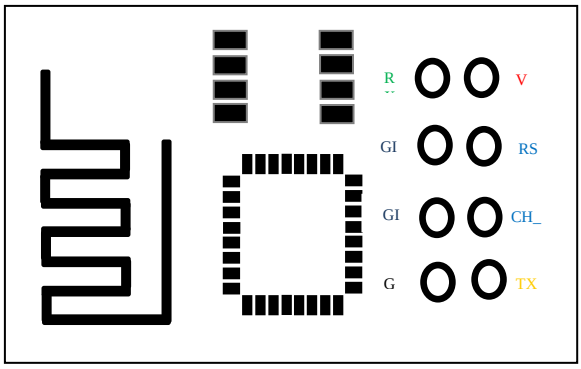

Fig.5 Pin Diagram of ESP8266

This ESP8266 module is an extremely cost effective board with a huge, and ever growing, community. The module can even be reprogrammed to act as a standalone Wi-Fi connected device–just add power.This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area.

The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts. The ESP8266 Module is not capable of 5V so 5-3.3V logic shifting and will require an external Logic Level Converter.

The key features of ESP8266

- 802.11 b/g/n
- Wi-Fi Direct (P2P), soft-AP
- Integrated TCP/IP protocol stack
- Integrated TR switch, LNA, power amplifier and matching network
- Integrated PLLs, regulators, DCXO and power management units
- +19.5dBm output power in 802.11b mode
- Power down leakage current of <10Ua
- 1MB Flash Memory
- Integrated low power 32-bit CPU could be used as application processor
- SDIO 1.1 / 2.0, SPI, UART
- STBC, 1×1 MIMO, 2×1 MIMO
- A-MPDU & A-MSDU aggregation & 0.4ms guard interval
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0Mw

G. Liquid Crystal Display

LCD stands for **L**iquid **C**rystal **D**isplay. LCD is finding wide spread use by replacing LEDs (seven segment LEDs or other multi segment LEDs) because of the ability to display numbers, characters and graphics. Incorporation of a refreshing controller into the LCD, thereby relieving the CPU of the task of refreshing the LCD and also the ease of programming for characters and graphics. It is based on the HD44780 microcontroller (*Hitachi*) and can display messages in two lines with 16 characters each. It displays all the alphabets, 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. It is based on the HD44780 microcontroller (*Hitachi*) and can display messages in two lines with 16 characters each. It displays all the alphabets, 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. . It is based on the HD44780 microcontroller (*Hitachi*) and can display messages in two lines with 16 characters each. It displays all the alphabets, Greek letters, punctuation marks, mathematical symbols etc. In addition, it is possible to display symbols that user makes up on its own.

H. Interfacing with ESP8266

The interfacing of ARM7 LPC2148 microcontroller with ESP8266 Wi-Fi module is done with the use of Max232 IC as an interface between them. The power supply used is 3.3V for both the microcontroller and MAX232 IC. The four GPIO port 0 pins of LPC2148(p0.0,p0.8,p0.1,p0.9) are

connected to transmit input and receive output pins of MAX232. The transit output and receive input pins of MAX232 is connected to the DB9 male connector which is then connected to DB9 female connector in ESP8266 Wi-Fi module.

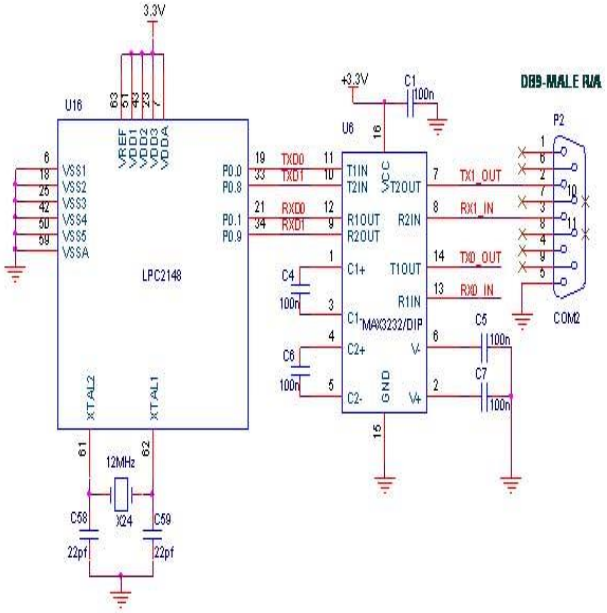

Fig. 6 Interfacing circuit between ARM7 and ESP8266

III. SOFTWARE TOOLS

The software used in the development of this system is Telnet application and Keil compiler.

A. Telnet Application

- Telnet is an application layer protocol used on the internet or local area network to provide a bidirectional interactive text oriented communication facility using a virtual terminal connection Telnet even predates internetworking and the modern IP packet and TCP transport layers.
- The TELNET protocol provides a standardized interface, through which a program on one host (the TELNET client) may access the resources of another host. (the TELNET server) as though the client were a local terminal connected to the server.
- For example, a user on a workstation on a LAN may connect to a host attached to the LAN as though the workstation were a terminal attached directly to the host. Of course, TELNET may be used across WANs as well as LANs.

B. Keil uvision

µVision is a window-based software development platform that combines a robust and modern editor with a project manager and make facility tool. It integrates all the tools needed to develop embedded applications including a C/C++ compiler, macro assembler, linker/locator, and a HEX file generator. µVision helps expedite the development process of embedded applications by providing the source code editor, device database, Debugger with simulator and flash programming utility.

IV. RESULTS

A. Traffic Density Evaluation

For detecting current traffic density using IR sensors the on and off condition is used, whenever vehicle is stayed between IR transmitter and IR receiver the sensor is in off state, then it sends this to microcontroller thereby “density in R1” is displayed in LCD and also in mobile using Wi-Fi technology through Telnet application.

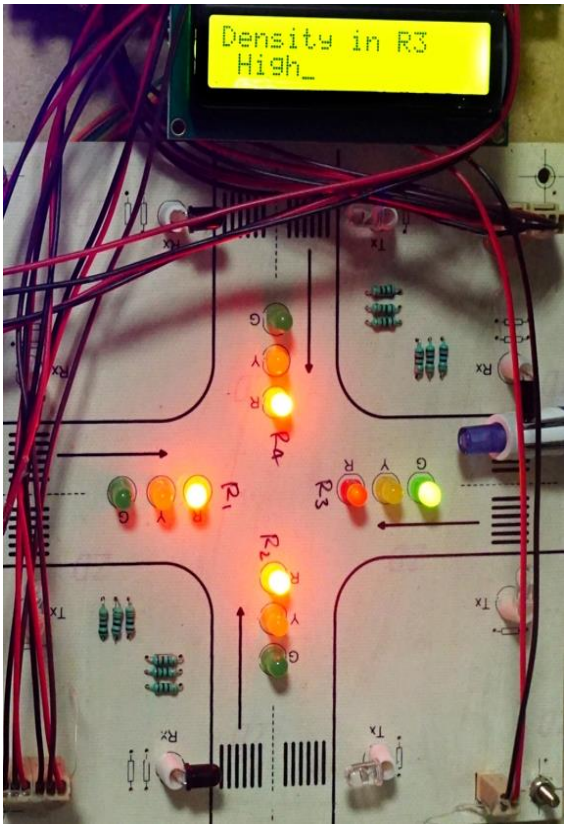

Fig 7 Traffic density result displayed on LCD

A. Traffic signal overriding

The traffic signal overriding is done by using RFID technology. If there is any emergency vehicle like ambulance, FIR engine or VIP vehicle with an RFID tag ,the RFID reader placed at certain distance from junction in road 1 reads the RFID tag and it sends this signal to microcontroller thereby “Ambulance is coming” is

displayed in LCD and also in mobile using Wi-Fi technology through Telnet application.

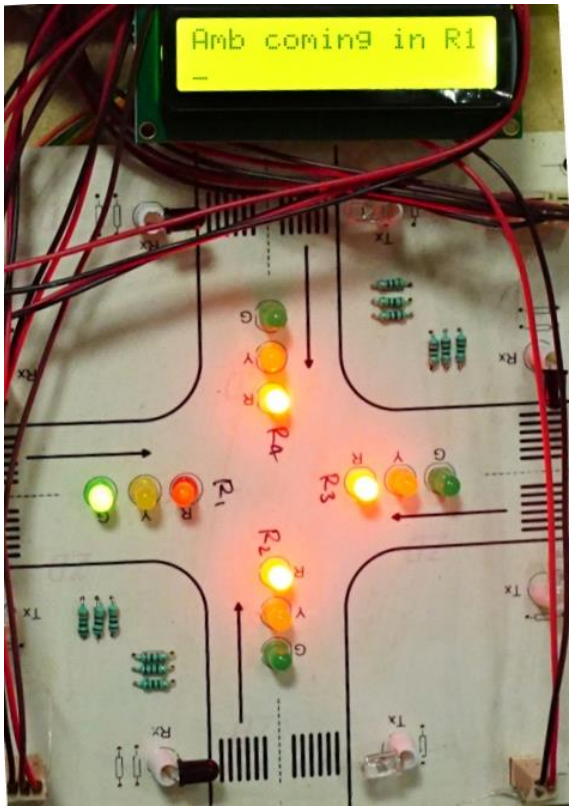

Fig 8 Traffic signal overriding displayed on LCD

V. CONCLUSION AND FUTURE SCOPE

This paper is used for optimization of traffic light controller by using IR Sensors for current traffic density information which is displayed in the LCD and also sent to users smart phone through Wi-Fi technology. This system is used to reduce traffic jams caused by traffic lights delay and also by the response of current traffic updates information to the smart phone users to an extent and will get successful results if implemented.

In future an efficient application is designed for getting this current traffic density information along with GPRS route map with colour coding depending on level of density for better visualization to user.

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About Author

Sujitha Kamireddi received my B.Tech degree in Electronics and Communication Engineering from Jogaiah Institute of Technology and sciences in 2012 and I am presently pursuing my Masters Degree in Embedded Systems and as a PG Scholar I am herewith presented my idea towards eradication of Traffic congestions in many major cities and to make lives of people over there more simple.